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STATISTICAL PACKAGE USER'S GUIDE

Julie A. Hopson and George A. Cotsonis

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NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY

PENSACOLA, FLORIDA

ERRATA SHEET for NAMRL Special Report 80-3

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The following corrections should be made to subject report.

Page No.	Line No.	Correction
iii	II.B.4.	ANOVA, One Repeated Measure vice ANOVA, Repeated Measures
iii	II.C.2.	One-way ANOVA vice Two-way ANOVA
iv	II.D.6.	Rotation vice Location
34	22	Add as last sentence to Test Data: The same data used in SRM30 (See SRM30) was used for testing program.
41	12	$X_{ij} = u$ vice $X_{ij} = i$
61	1	One Repeated Measure vice Repeated Measures
77	12	$B_j + C_k$ vice $B_j - C_k$
110	24	Add the following columns to the bottom of page:

RAW DATA

3.000	4.000	7.000	7.000
6.000	5.000	8.000	8.000
3.000	4.000	7.000	9.000
3.000	3.000	6.000	8.000
1.000	2.000	5.000	10.000
2.000	3.000	6.000	10.000
2.000	4.000	5.000	9.000
2.000	3.000	6.000	11.000

144	13/15	$(X_{ijm} - \bar{X}_{ij.}) = u + A_i + B_j + AB_{ij} + \P_{m(i)} + B\P_{jm(i)} + E_{ijm}$ vice $(X_{ijm} - \bar{X}...) = u + A_i - B_j + AB_{ij} + \Sigma_{m(i)} + B\Sigma_{jm(i)} + E_{ijm}$
164	1	One-way ANOVA vice Two-way ANOVA
174	12	$= u_{(r)}$ vice $= M_{(r)}$
247	1	(Varimax Rotation) vice (Varimax Location)

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SUMMARY

The Statistical Package User's Guide represents an aggregation of a variety of statistical analysis. The types of statistical programs available are: Analysis of Variance, Analysis of Covariance, Multivariate Analysis of Variance, Regression Analysis, Factor Analysis, Descriptive Statistics, and Nonparametric Statistics. The User's Guide provides the following documentation for each program: General Description, Mathematical Model, Operational Procedures, Test Data Statistical Analysis, and Software Coding.

ACKNOWLEDGEMENTS

The Statistical Package is the culmination of the efforts of many persons in developing, converting and implementing the programs involved. The authors wish to acknowledge all those who have contributed to this project. Special thanks are due to Peter Collyer for his programming efforts, Del Turner for his typing of the manuscript, and Dr. J. E. Goodson for supporting the project. The authors wish to thank Mr. John Bowman for his guidance and assistance in our understanding and utilization of the available hardware and systems capabilities, and for his diagnostic and corrective actions during test and evaluation of several of the programs. Particular acknowledgement is due Rachel Gadolin for her efforts in the delivery of the final product.

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INTRODUCTION

The Statistical Package User's Guide represents an attempt to aggregate a variety of statistical programs in the Aerospace Psychology Department at the Naval Aerospace Medical Research Laboratory (NAMRL) into one standard package. Some of the statistical programs included in the statistical package were developed at the Naval Aerospace Medical Research Laboratory for the UNIVAC 418 and NOVA 800; others were programs obtained from different universities with multifarious computer capability and programming languages. Selection of programs in the statistical package was based upon investigator needs and computer core requirements. The intention was to provide a diversity of basic statistical programs for experimental investigators which matched research requirements and which could be readily utilized in the majority of the Naval Aerospace Medical Research Laboratory computer facilities.

For standardization, all statistical programs were coded in Fortran IV language and sized to fit a mini-computer with 32k memory. The programs were originally converted to a Hewlett Packard (HP) 2100 mini-computer but were structured so that only minor changes in the input/output (I/O) requirements (i.e., device codes and disk file formats) would be necessary for the statistical package to be compatible with another system. Programs were also structured so that they could be used by investigators with limited computer skills. It was intended that the organizational/structural philosophy of the statistical package serve as a guideline for new programs. If the same general philosophy is adhered to when developing other statistical analyses, new programs could be readily shared by multiple users, thereby expanding the statistical package with minimal programming efforts and costs.

Once the programs were converted to the HP mini-computer, each was checked carefully for accuracy. Documented data were obtained from specific sources to check the calculation of the statistical analyses. An estimate of the digit accuracy was obtained by comparing the results of the HP calculation with those obtained from other computing sources. Most comparisons were made using the Statistical Analyses System and the Statistical Package for Social Sciences, two data analysis packages residing on the IBM 360 system at University of West Florida. Most of the programs were accurate to ten digit places; exceptions to this are noted in the user's guide. When comparison analyses were done with systems that had less computing power than the HP-2100, double precision was used in the calculations to insure minimal rounding-off errors. All data analyses performed on the HP-2100 have been included in the guide so that calculations can be double checked if a malfunction is suspected or to verify whether the operator is entering the data properly.

Standard operating procedures for a specific system is the only computer skill needed to use the statistical package. It will be necessary to generate a separate data file prior to calling up a specific analysis. The data files can either be created using DA30 or constructed during an experimental run. The format of the data is dependent upon the desired statistical analysis and is specified in the guide. When a data file is not organized appropriately, edit or sorting commands of the system being used is typically adequate to rearrange files in the necessary format. For other systems, it may be desirable to write a generalized utility program to change data file organization.

The notation used for the formulas in the statistical package should be familiar to the general user. Although alphanumeric letters are used in the models rather than standard greek letters, with the exception of Tau (π), the reader should have no difficulty in interpreting the equations. For a few cases, computer notation was used (i.e., transformation equations). For these, the following notiation is utilized:

* = multiplication sign

$x** = x^2$

$x**^{.5} = \sqrt{x}$

The Analysis of Variance and Covariance programs were given two names; i.e., AV10 and CR-k. Since these analyses were developed from designs specified by Roger E. Kirk, <u>Experimental Design Procedures for the Behavioral Sciences</u>, the unique nomenclature he used for specific designs was maintained in the guide for reference. When calling up any of these statistical programs, only the AV or AC notation will be accepted. For the split-plot analyses the AV notation is accompanied by alphanumeric letters to indicate which factors are the within variables. AV31C means that A and B are the between group factors and C the within factor.

I. UTILITY PROGRAMS

DA30 (Data File Creation)

Purpose:

This program creates data files for the stat-pack on the HP2100. The data are entered by hand at the computer console and permanently stored on the disc.

User Considerations and Procedures:

1. Check "User Considerations and Procedures" of the various statistical programs to see how the data should be formatted - some require data in matrix form, others in sequential form.

2. DA30 will ask for the following

   a. format for data output. This is the format per line of data required for the statistical program. Respond by giving any legal HP-FORTRAN IV format statement, enclosing the format in parentheses. For example:

      1) (I5)
      2) (I5, F7.3, F9.7, I6)
      3) (30, (1X, F10.4))

      NOTE: The word format should not be given.

   b. Logical record length. This is the number of characters per line of data created. Spaces should be included. For the example above, the record lengths are:

      1) 5
      2) 5 + 7 + 9 + 6 = 27
      3) 30 * (1 + 10) = 30 * 11 = 330

      The maximum length is 512 characters per line.

   c number of observations across. This is the number of variables per line. (Some statistical programs require one per line, others require many.) For the three examples above, this is:

      1) 1
      2) 4
      3) 30

d. number of levels down. This is the number of records to be created in the file. The maximum number of records that can be contained in a file is 32767.

e. data file name. Enter name of the file to be created (maximum of six characters)

NOTE: Imbedded blanks are illegal. Do not use a name that is already stored on the disc.

3. Procedures for entering data via keyboard:

a. to enter only one variable per record, enter value, then hit 'return'

b. to enter 10 or fewer variables per record, enter the values by row, separating each with a comma. Terminate the row with a 'return'

c. to enter more than 10 variables per record, enter data across in groups of 10 variables. Separate each variable with a comma, and terminate each 10 with a 'return'. For example, for 17 variables per line, enter first 10 values separating each by a comma, hit 'return', enter next 7 values separating each by a comma, hit 'return', then go to next record

Comments:

Keep a separate memo of the name, format, and record length for use in stat-pack programs. This is not saved on the disc file.

To purge a data file from the disc, enter: PU, 'data file name'; PK, 2.

To store a data file on tape run the STORT program. The purge option can be used to delete the data file from the disc.

```
 RU,DA3Ø
 DATA3Ø
 CREATE A DATA FILE FOR INPUT TO STAT PKG.
 INPUT TO DATA FILE IS A 2-DIMENSIONAL ARRAY
MAXIMUM OF 3Ø VALUES ACROSS,    32767   VALUES DOWN
NO RECORD IS KEPT OF FILE ORGANIZATION
ENTER OUTPUT FILE NAME - UP TO 6 CHARACTERS
YEWT
  ENTER LENGTH OF RECORD :  FOR EXAMPLE
 IF YOUR FORMAT IS (15(5X,F1Ø.4)) YOUR LENGTH WOULD BE
   15 * (5 + 1Ø ) =  225
18Ø
  ENTER DESIRED OUTPUT FORMAT
(3Ø(1X,F5.1))
ENTER # OF OBSERVATIONS ACROSS
3Ø
 ENTER # OF LEVELS DOWN
3
ENTER DATA VALUES BY ROWS IN GROUPS OF 1Ø
 VARIABLES, SEPARATE EACH DATA VALUE BY A COMMA
TERMINATE EACH 1Ø WITH CARRIAGE RETURN, IE :
IF YOU HAD 17 VARIABLES ENTER IN FIRST 1Ø , HIT 'RETURN'
THEN ENTER FINAL 7 AND HIT 'RETURN'

 ROW     1
1,2,3,4,5,6,7,8,9,1Ø
11,12,13,14,15,16,17,18,19,2Ø
21,22,23,24,25,26,27,28,29,3Ø
 ROW     2
1Ø,2Ø,3Ø,4Ø,5Ø,6Ø,7Ø,8Ø,9Ø,1ØØ
11Ø,12Ø,129,156,178,333,444,555,666,777
888,999,111,222,345,456,567,678,789,89Ø
 ROW     3
15,25,35,45,55,65,75,85,95,1Ø5
29,39,49,59,99,1Ø9,76,35,33,22
11,22,33,44,55,66,77,88,99,Ø
 YOUR DATA FILE YEWT   IS NOW CREATED,
 :
```

"DA30 T=00003 IS ON CR00002 USING 00014 BLKS R=0000

```
FTN4
            PROGRAM DA30
            DIMENSION ACROSS(100),NAMA(3),ID(272)
            DIMENSION IBUF(257),ISIZE(2),IFMT(20)
            WRITE(1,17)
 17         FORMAT(" DATA30 ",/," CREATS A DATA FILE FOR INPUT TO ",
           1"STAT PKG. ",/," INPUT TO DATA FILE IS A 2-DIMENSIONAL"
           2," ARRAY",/,"MAXIMUM OF 30 VALUES ACROSS, UNLIMITED  "
           3,"VALUES DOWN",/,"NO RECORD IS KEEP OF FILE ORGANIZATION",
           4/,"ENTER OUTPUT FILE NAME - UP TO 6 CHARACTERS")
            READ(1,18) NAMA
 18         FORMAT(3A2)
 234        FORMAT(20A2)
            WRITE(1,703)
 703        FORMAT("  ENTER LENGTH OF RECORD :  FOR EXAMPLE ")
 756        WRITE(1,705)
 705        FORMAT(" IF YOUR FORMAT IS (15(5X,F10.4)) YOUR LENGTH WOULD BE",
           1/,"   15 * (5 + 10 ) =  225")
            READ(1,*) LENGTH
            LEN=LENGTH/2
            IF((LEN*2).NE.LENGTH) LEN=LEN+1
            LENGTH=LEN
            IF(LEN.LE.256) GO TO 256
            WRITE(1,706)
 706        FORMAT( " LENGTH IS TOO LARGE, MAX IS 512")
            GO TO 756
 256        IDCBS=256
            ISIZE(2)=LENGTH
 120        WRITE(1,5558)
 5558       FORMAT("  ENTER DESIRED OUTPUT FORMAT")
            READ(1,234) IFMT
            WRITE(1,30)
 30         FORMAT( "ENTER # OF OBSERVATIONS ACROSS")
            READ(1,*) NLEV
            WRITE(1,31)
 31         FORMAT(" ENTER # OF LEVELS DOWN")
            READ(1,*) NGRPS
            SIZE=LENGTH
            XGRPS=NGRPS
            SIZE=XGRPS*SIZE/128. + 1.
            ISIZE(1)=SIZE
 755        CALL CREAT(ID,IERR,NAMA,ISIZE,2,0,-2,IDCBS)
            IF(IERR.GT.0) GO TO 100
            WRITE(1,13) IERR
 13         FORMAT(" ERROR # ",I5," AT CREATING FILE ")
            STOP 13
 100        CALL CLOSE(ID)
            CALL OPEN(ID,IER,NAMA)
            IF(IER.GE.0) GO TO 124
 52         WRITE(1,459) IER
 459        FORMAT(" FAILED TO OPEN , IER = ",I5)
            STOP 457
```

```
124   IF(NLEV.GT.10) GO TO 666
      WRITE(1,32)
32    FORMAT(" ENTER DATA VALUES BY ROW,SEPARATED WITH ",
     1"COMMAS",/," TERMINATE ROW WITH CARRIAGE RETURN")
      DO 41 J2=1,NGRPS
      DO 66 I=1,NLEV
66    ACROSS(I)=0.0
      WRITE(1,42) J2
42    FORMAT(" ROW ",I5)
      READ(1,*)(ACROSS(J3),J3=1,NLEV)
      CALL CODE
      WRITE(IBUF,IFMT)(ACROSS(J3),J3=1,NLEV)
      CALL WRITF(ID,IER,IBUF)
      IF(IER.GE.0) GO TO 41
      WRITE(1,44) IER
44    FORMAT("ERROR @ ",I5," AT FILE WRITING")
      CALL CLOSE(ID)
      STOP 44
41    CONTINUE
      GO TO 555
666   WRITE(1,777)
777   FORMAT("ENTER DATA VALUES BY ROWS IN GROUPS OF 10",/
     $," VARIALBES, SEPERATE EACH DATA VALUE BY A COMMA",/,
     %"TERMINATE EACH 10 WITH CARRIAGE RETURN, IE ! ",/,
     &"IF YOU HAD 17 VARIALBES ENTER IN FIRST 10 , HIT 'RETURN'",
     !/"THEN ENTER FINAL 7  AND HIT 'RETURN'"/ )
      IN=(9+NLEV)/10
      DO 51 J2=1,NGRPS
      DO 67 I=1,NLEV
67    ACROSS(I)=0.
      WRITE(1,42) J2
      DO 68 I=1,IN
      K=10* I
      L=(I-1)*10 + 1
68    READ(1,*) (ACROSS(J3),J3=L,K)
      CALL CODE
      WRITE(IBUF,IFMT) (ACROSS(J3),J3=1,NLEV)
      CALL WRITF(ID,IER,IBUF)
      IF(IER.LT.0) GO TO 52
51    CONTINUE
555   WRITE(1,166) NAMA
166   FORMAT(" YOUR DATA FILE ",3A2," IS NOW CREATED.",/,
     1" THIS PROGRAM IS FINISHED ")
      CALL CLOSE(ID)
      END
      END$
```

STORT (Data File Storage/Retrieval)

Purpose:

This program performs either of two operations:

Storage of data files onto tape (for backup purposes and/or permanent storage)
Retrieval of data files stored on tape

User Considerations and Procedures:

1. Data files transferred to tape will keep their same format and record length as on the disc. When tape files are retrieved, the data file can be renamed and stored on the disc.

2. Option for storage or retrieval. Enter 1 for storage of data file onto tape, and 2 for retrieval of data file from tape to the disc.

3. When option for storage onto tape is used, the program will ask if the data file is to be purged (deleted from the disc). Enter 1 for deletion, and 2 for keeping data file on disc.

4. Parameters required:

   a. name of data file

      1) for storing data, this is the name of the disc data file to be transferred
      2) for retrieving a data file, this is the name of the disc file which the data will be transferred to

   b. tape file number

      1) for storing data, program asks for the next available tape file number where the data can be stored. Files are stored on tape sequentially
      2) to retrieve data, program asks for the number of the tape file to be returned to a disc file

```
RU,STORT
:SV,4
THIS PROGRAM STORES AND RETRIEVES DATA FILES CREATED
 BY DA3Ø AND TRAFM PROGRAMS ONTO TAPE FILES TO BE USED LATER.  NOW, MOUNT
 DATA TAPE AND ENTER 1 WHEN THROUGH
1
ENTER NAME OF DATA FILE
#FATAA
ENTER 1 FOR STORAGE ONTO TAPE, OR 2 FOR RETREIVAL
1
ENTER NEXT AVAILABLE FILE # ON TAPE
2
STORT FINISHED WHEN TAPE STOPS
ENTER 1 TO PURGE DATA FILE FROM DISC ELSE ENTER Ø
Ø
:
```

*STORT T=00003 IS ON CR00002 USING 00010 BLKS R=0000

```
FTN4
        PROGRAM STOR
        DIMENSION IFMGR(3),INAME(3),IBUF1(6),IBUF2(6)
        DIMENSION IB(144),IBUF(144),NAME(3)
        DIMENSION IBUF3(6),ID(3)
        DATA IBUF3/2H:P,2HU,/
        DATA ID/2H:P,2HK,,2H02/
        DATA NAME/2HST,2HOT,2HR /
        DATA IBUF1/2H:S,2HT,,2H8,/
        DATA IBUF2/2H:S,2HT,/
        DATA IC/2H,8/
        J1=13108
        CALL OPEN(IB,IER,NAME)
        WRITE(1,99)
        REWIND 8
99      FORMAT("THIS PROGRAM STORES AND RETRIEVES DATA FILES CREATED ",
       $/," BY DA30 AND ",
       $"TRAFM PROGRAMS ONTO TAPE FILES TO BE USED LATER.  NOW, MOUNT",
       $/," DATA TAPE AND ENTER 1 WHEN THROUGH")
        READ(1,*) ITP
 60     IBUF2(6)=IC
        WRITE(1,1)
1       FORMAT("ENTER NAME OF DATA FILE")
        READ(1,2) INAME
2       FORMAT(3A2)
        WRITE(1,3)
3       FORMAT("ENTER 1 FOR STORAGE ONTO TAPE, OR 2 FOR RETREIVAL")
        READ(1,*) IST
        IF(IST.EQ.1) GO TO 100
        WRITE(1,6)
6       FORMAT("ENTER THE # OF THE FILE ON THE TAPE")
        READ(1,*) ITP
        IF(ITP.LE.1) GO TO 1040
        K=ITP-1
1040    DO 10 I=1,3
10      IBUF1(I+3)=INAME(I)
        CALL CODE
        WRITE(IBUF,23) IBUF1
        GO TO 20
100     WRITE(1,50)
50      FORMAT("ENTER NEXT AVAILABLE FILE # ON TAPE")
        READ(1,*) ITP
        IF(ITP.LE.1) GO TO 105
        K=ITP-1
105     DO 21 I=1,3
21      IBUF2(I+2)=INAME(I)
        CALL CODE
        WRITE(IBUF,23) IBUF2
20      CONTINUE
23      FORMAT(6A2)
        CALL WRITF(IB,IER,IBUF,6)
        WRITE(1,24)
24      FORMAT("STORT FINISHED WHEN TAPE STOPS")
```

```
      IF(K.EQ.0) GO TO 34
      DO 104 J=1,K
104   CALL EXEC(3,J1)
34    CALL EXEC(13,10B,I1,I2,I3)
      IF(I1.LT.0) GO TO 34
      IF(IST.EQ.2) GO TO 70
      WRITE(1,51)
51    FORMAT("ENTER 1 TO PURGE DATA FILE FROM DICS",
     $" ELSE ENTER 0")
      READ(1,*) ITEST
      IF(ITEST.NE.1) GO TO 70
      DO 52 J1=1,3
52    IBUF3(J1+2)=INAME(J1)
      CALL CODE
      WRITE(IBUF,53) IBUF3
53    FORMAT(5A2)
      CALL WRITF(IB,IER,IBUF,5)
      CALL CODE
      WRITE(IBUF,54) ID
54    FORMAT(3A2)
      CALL WRITF(IB,IER,IBUF,3)
70    CALL CLOSE(IB)
      END
      END$
```

EDIT (Data File Editor)

Purpose:

This program is a simple editing program to modify values in data files with large record lengths (i.e., those with lengths > 80). The program will change values of variable (i), subject (j). The program will also list the original data and the revised data in any output format specified, if requested.

User Considerations and Procedures:

1. Program expects data in a row x column (R x C) matrix form. Each line of raw data would have C (column) elements (all variables for subject (j)).

2. A listing of the data file can be obtained before editing. Option: 1 if raw data printout is desired, 0 for no printout. A listing of the revised data can only be obtained by rerunning the program after the necessary modifications have been made.

3. Data listings can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

4. If the option for data listing is used, the program will ask for the desired output format. When the raw data have been listed, enter 1 to end EDIT or 0 to continue with editing.

5. For each editing change desired, enter record number, variable number, and desired correction separating each by commas. For example, to change variable 22 of subject 10 from 39.5 to 29.5, type 10, 22, 29.5. Continue with the same procedure for other corrections, if any. When there are no more corrections to be made, type -999 -999 -999.

6. Parameters required:

   a. number of variables (maximum 100)

   b. number of subjects (maximum 32767)

   c. name of data file

   d. format and record length of file (see DA30)

   e. format used to list data (for legibility of data files)

   f. editing parameters and corrections

```
 RU,EDIT
ENTER NAME OF DATA FILE
#FATAA
ENTER FORMAT OF DATA
(8(2X,F6.2))
ENTER NUMBER OF VARIABLES
8
ENTER NUMBER OF SUBJECTS(RECORDS)
32
 ENTER THE RECORD LENGTH AS IN DA3Ø
64
 ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER
1
ENTER 1 FOR DATA LISTING
Ø
ENTER IN ORDER 'RECORD #,VARIABLE #, CORRECTION
 IE,  TO CHANGE THE VALUE OF VARIABLE 5 OF SUBJECT 1Ø
 TO 29.5 TYPE
             1Ø,5,29.5
WHEN YOU ARE THROUGH WITH ALL CORRECTIONS TYPE IN
            -999,-999,-999
3,5,678.1
5,8,599.9
15,6,435.12
24,1,39.5
31,2,45.6
-999,-999,-999
EDITING FINISHED
:
```

```
*EDIT  T=00003 IS ON CR00002 USING 00010 BLKS R=0000

FTN4,L
      PROGRAM EDIT
      COMMON IB(272),IBUF(256),INAME(3),IFMT1(20),IFMT2(20),X(100)
      WRITE(1,1)
1     FORMAT("ENTER NAME OF DATA FILE")
      READ(1,2) INAME
2     FORMAT(3A2)
      WRITE(1,3)
3     FORMAT("ENTER FORMAT OF DATA")
      READ(1,4) IFMT1
4     FORMAT(20A2)
      WRITE(1,13)
13    FORMAT("ENTER NUMBER OF VARIABLES")
      READ(1,*) NVAR
      WRITE(1,11)
11    FORMAT("ENTER NUMBER OF SUBJECTS(RECORDS)")
      READ(1,*) NSUB
      WRITE(1,88)
88    FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
      READ(1,*) LENGTH
      LEN=LENGTH/2
      IF((LEN*2).NE.LENGTH) LEN=LEN+1
      LENGTH=LEN
      IDCBS=LENGTH
      IF(LENGTH.LT.144) IDCBS=144
      CALL OPEN(IB,IER,INAME,3,0,-2,IDCBS)
      IF(IER.GE.0) GO TO 100
      WRITE(1,5) INAME,IER
5     FORMAT(3A2,"  FAILED TO OPEN , IER = ",I5)
      STOP 5
100   WRITE(1,6)
6     FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER")
      READ(1,*) IUNIT
      WRITE(1,7)
7     FORMAT("ENTER 1 FOR DATA LISTING")
      READ(1,*) ICOM
      IF(ICOM.NE.1) GO TO 1100
10    FORMAT("ENTER OUTPUT FORMAT DISIRED")
1000  WRITE(1,10)
      READ(1,4) IFMT2
      DO 1012 J=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT1)(X(I),I=1,NVAR)
      WRITE(IUNIT,133)
133   FORMAT(5X)
1012  WRITE(IUNIT,IFMT2) (X(I),I=1,NVAR)
      WRITE(1,17)
17    FORMAT("ENTER ONE TO END EDIT")
      READ(1,*) ICOM
      IF(ICOM.EQ.1) STOP 17
```

```
1100  WRITE(1,18)
18    FORMAT("ENTER IN ORDER 'RECORD #,VARIALBE #, CORRECTION",/
     $"IE,  TO CHANGE THE VALUE OF VARIABLE 5 OF SUBJECT 10",/
     %" TO 29.5 TYPE",/,10X," 10,5,29.5",/,"WHEN YOU ARE THROUGH",
     &" WITH ALL CORRECTIONS TYPE IN ",/,10X,"-999,-999,-999")
      DO 1111 J=1,10000
      READ(1,*) K,L,Z
      IF(K.EQ.-999) GO TO 999
      CALL READF(IB,IER,IBUF,IDCBS,LEN,K)
      CALL CODE
      READ(IBUF,IFMT1) (X(I),I=1,NVAR)
      X(L)=Z
      CALL CODE
      WRITE(IBUF,IFMT1) (X(I),I=1,NVAR)
      CALL WRITF(IB,IER,IBUF,0,-1)
      CALL RWNDF(IB)
1111  CONTINUE
999   WRITE(1,16)
16    FORMAT("EDITING FINISHED")
      END
      END$
```

TRAFM (Data Transformation)

Purpose:

This program is used to create a new data set based on a transformation of an old data set. TRAFM can transform data that are in matrix form or in sequential (continuous) form. The program performs the following 11 transformations:

1 = reciprocal (1/x)
2 = square root
3 = $\log_{10}$
4 = Z score $\frac{x - \text{mean}}{SD}$ using mean and standard deviation of all desired variables
5 = $\frac{1}{2} \log_{10} (1 + x)/(1 - x)$
6 = x + constant
7 = x - constant
8 = x * constant
9 = x / constant
10 = 2 arcsin (x**.5) = 2 arcsin $\sqrt{x}$
11 = Z score by individual means and standard deviations

User Considerations and Procedures:

1. Program creates a new data file. Caution should be taken to format the new data to correspond to the requested transformation. For example, reciprocal data will require decimal notation.

2. Program needs to know the type of data file which will be used. Enter 1 if data are in sequential form, enter 0 if in matrix form.

3. For data in matrix form:

   a. program asks for number of subjects twice. Respond both times with the number of rows in the matrix file

   b. program asks for number of variables per subject (columns). Respond with the number of columns in the matrix file (maximum 30)

   c. program asks if the same transformation is desired for all variables. Respond 1 for yes, 0 for no

   d. if a 0 response was given to the above (c), program asks for the variable number (column) that is to be transformed. Then, program asks if more transformations are desired. Respond 1 for yes, or 0 for no. On a response of 1, the sequence is repeated

4. For data in a sequential form: (program expects data to index for subjects first, then for variables, with one subject per line).

   a. program asks for number of subjects in TRAFM file; respond with the total number of records in the data file

   b. program asks for number of variables in data file. This allows some leeway in breaking up or partitioning the transform file. If there is no logical way to partition the file, enter 1 for only one variable. In most cases, number of variables is the number of groups of subjects

   c. same as 3-c

   d. same as 3-d

   e. programs ask for number of subjects for each variable. Respo with the number of subjects in each group

5. Parameters required:

   a. type of transform required. Enter the numberical code which corresponds to the correct transformation. When the transformation is finished, enter 0 to end the program, or enter 1 to perform another transformation.

   b. name of old file

   c. name of new TRAFM file

   d. format and record length of old data file (see DA30)

   e. format and record length of new data file (see DA30)

   f. other parameters required for certain transformation such as largetst positive number of constant to be used. For more information, see comments

6. There is no printout of the original or transformed data.

Comments:

Uses and special considerations for each transformation.

1. Reciprocal

   This is used to normalize data when the raw data are skewed to the right. If a raw value is 0, the program arbitrarily assigns a value of 1. This transformation improves homoscedasticity of the distribution.

2. Square Root

This is used to normalize rightly skewed data. Program asks for the largest negative number in absolute value (C). The actual transformation is SQRT (x + C) when x is less than or equal to ten. This transformation improves the homoscedasticity of the distribution.

3. Log_{10}

This is the strongest transformation to normalize rightly skewed data. It may pull in the right tail too far and create outliers on the left side of the distribution. When this occurs, transformation 1 or 2 above is warranted. Program requires that the largest negative number in absolute value (C) be inputed. The actual transformation is log (x + C + 1). The log transform is the most powerful in improving homoscedasticity and can be used solely for this purpose.

4. Z Score

This transformation can be performed by using the mean and standard deviation of all the variables in the data file or by the mean and standard deviation of the specific variable (column) to be transformed. Respond 1 if the transform should be based on all data, or 0 if calculations are to be based on only the specified transform variable.

5. ½ Log ((1 + x)/(1 - x))

This is used to transform left skewed distributions or platykurtic distributions. Program requires highest positive number (C) to be given and the highest negative number in absolute value (C_2). The actual transformation is:

½ Log ((1 + x')/(1 - x')), where $x' = (x + C_2)/(C_2 + C + 1)$.

6. x + Constant

This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

7. x - Constant

This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

8. x * Constant

This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

9. x / Constant

This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

10. 2 arcsin $\sqrt{x}$

This transformation is applicable for left-skewed distributions or playtkurtic distributions. Data must be proportional data; i.e., $0 \leq x \leq 1$. This transformation is useful in many non-parametric procedures.

11. Individual Z Score

This transformation is done by standardization of desired variables by their individual means and standard deviations.

Test Data:

Program was tested by comparing data output with calculator analysis and the Statistical Analysis System. Transformation involving logs or sines are accurate to five digits; other transformations are accurate to six digits.

```
RU,TRAFM

  PROGRAM TO TRANSFORM DATA

 TYPE OF TRANSFORM
 Ø = STOP
 1 = RECIPICAL 1/X
 2 = SQUARE ROOT (X)**.5
 3 = LOG(1Ø)X
 4 = Z SCORE=(X-MEAN)/SD
 5 = 1/2 LOG ((1+X)/(1-X))
 6 = X + CONSTANT
 7 = X - CONSTANT
 8 = X * CONSTANT
 9 = X / CONSTANT
 1Ø = 2 ARCSIN (X**.5) - MUST BE PROPORTIONAL DATA<15>
 11 = Z SCORE BY INDIVIDUAL VARIABLE MEAN AND SD
 ENTER BY NUMBER THE TRANSFORMED DESIRED:
11
 DATA FILENAME
#FATAA
 DATA FORMAT
(8(2X,F6.2))
 NEW DATA FILENAME
#ZSCR
 ENTER THE RECORD LENGTH AS IN DA3Ø
64
  INPUT NUMBER OF SUBJECTS IN TRAFM FILE
32
 NUMBER OF VARIABLES PER SUBJECT :
8
 DO YOU WISH TRANSFORMATIONS ON ALL VARIABLES, 1 = YES , Ø - NO
1
 TYPE OF DATA FILE 1 = CONTINUOUS , Ø = MATRIX :
Ø
 NUMBER OF SUBJECTS :
32
 TRANSFORMATION TYPE    11  IS FINISHED
 TO STOP ENTER Ø, FOR MORE ENTER ANY OTHER NUMBER
Ø
  TRAFM : STOP    ØØØØ
:
```

```
*TRAFM T=00004 IS ON CR00002 USING 00053 BLKS R=0449

FTN4
      PROGRAM TRAFM
      DIMENSION NAME(3),INAME(3),IFMT(20),IDATA(30),DTA(30),IZ(30)
      DIMENSION IB(272),IC(272),IBUF(256),ICUF(256),ISIZE(2)
      DIMENSION SUM1(30),SUM3(30),XBR(30),STD(30)
      DIMENSION IFMT1(20)
50    WRITE(1,277)
277   FORMAT(//," PROGRAM TO TRANSFORM DATA ",//,/,
     C" TYPE OF TRANSFORM" ,/,
     C" 0 = STOP" ,/,
     C" 1 = RECIPICAL 1/X" ,/,
     C" 2 = SQUARE ROOT (X,/,**.5" ,/,
     C" 3 = LOG(10)X" )
      WRITE(1,4405)
4405  FORMAT ( " 4 = Z SCORE (X-MEAN)/SD" ,/,
     C" 5 = 1/2 LOG ((1+X)/(1-X))",/,
     C" 6 = X + CONSTANT" ,/,
     C" 7 = X - CONSTANT" ,/,
     C" 8 = X * CONSTANT" ,/,
     C" 9 = X / CONSTANT" )
      WRITE(1,4411)
4411  FORMAT ("10 = 2 ARCSIN (X**.5) - MUST BE PROPORTIONAL DATA(15)"
     C,/," 11 = Z SCORE BY INDIVIDUAL VARIABLE MEAN AND SD",/,
     C" ENTER BY NUMBER THE TRANSFORMED DESIRED: ")
      READ(1,*) ITEST
      IF(ITEST.EQ.0)GO TO 61
      WRITE(1,4413)
4413  FORMAT ("ENTER INPUT DATA FILENAME" )
      READ(1,30)NAME
30    FORMAT(3A2)
      WRITE(1,4414)
4414  FORMAT ( " DATA FORMAT" )
      READ(1,130)IFMT
130   FORMAT(20A2)
      WRITE(1,4238)
4238  FORMAT("ENTER THE INPUT RECORD LENGTH AS IN DA30")
      READ(1,*)LENGTH
      WRITE(1,4415)
4415  FORMAT ( " NEW DATA FILENAME" )
      READ(1,30)INAME
      WRITE(1,4673)
4673  FORMAT("ENTER OUTPUT DATA FORMAT")
      READ(1,130) IFMT1
      IDCBS=256
      ISIZE(1)=-1
      ISIZE(2)=LENGTH
      CALL CREAT(IC,IER1,INAME,ISIZE,2,0,-2,IDCBS)
      IF(IER1.GE.0) GO TO 379
      WRITE(1,981)
981   FORMAT(" INPUT NUMBER OF SUBJECTS IN TRAFM FILE")
```

```
      READ(1,*) NSU
      SIZE=LENGTH
      XNSU=NSU
      SIZE=XNSU*SIZE/128. + 1.
      ISIZE(1)=SIZE
      CALL CREAT(IC,IER,INAME,ISIZE,2,0,-2,IDCBS)
      IF(IER.GE.0) GO TO 379
879   WRITE(1,378) INAME,IER
      CALL CLOSE(IB)
      STOP 3715
379   K4=0
      CALL OPEN(IB,IERR,NAME,3,0,-2,IDCBS)
      IF(IERR.GE.0) GO TO 377
      WRITE(1,378) NAME,IERR
378   FORMAT(1X,3A2," FAILED TO OPEN, ERROR # ",I5)
      CALL PURGE(IC,IER,INAME)
      STOP 371
377   WRITE(1,4416)
4416  FORMAT ( " NUMBER OF VARIABLES PER SUBJECT :    ")
      READ(1,*)  IV
      WRITE(1,4417)
4417  FORMAT(" DO YOU WISH TRANSFORMATIONS ON ALL VARIABLES,"
     1," 1 = YES , 0 - NO ")
      READ(1,*)  IFT
      IF(IFT.EQ.0)GO TO 20
      DO 19 K=1,IV
19    IDATA(K)=1
      GO TO 31
20    DO 21 K=1,IV
21    IDATA(K)=0
22    WRITE(1,4418)
4418  FORMAT ( " TRANSFORM ON VARIABLE #    ")
      READ(1,*) ITRN
      IDATA(ITRN)=1
      WRITE(1,4419)
4419  FORMAT ( " ANY MORE TRANSFORMS 1 = YES , 0 = NO   ")
      READ(1,*)  ITRN
      IF(ITRN.EQ.1)GO TO 22
31    WRITE(1,4420)
4420  FORMAT ( " TYPE OF DATA FILE 1 = CONTINIOUS , 0 = MATRIX :    ")
      READ(1,*) IFLE
      IF(IFLE.EQ.1.AND.ITEST.EQ.11) GO TO 11
      IF(IFLE.EQ.1)GO TO 32
      WRITE(1,4421)
4421  FORMAT ( " NUMBER OF SUBJECTS        ")
      READ(1,*) NSUB
      IDPT=IV
      IV=0
      GO TO 33
32    K4=K4+1
      WRITE(1,4422) K4
4422  FORMAT ( " NUMBER OF SUBJECTS FOR VARIABLE #  ",I5  )
      READ(1,*) NSUB
      IDPT=1
33    GO TO (1,2,3,4,5,6,7,8,9,10,11)ITEST
```

```
1     DO 100 K=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(K4.EQ.0)GO TO 102
      J=K4
      GO TO 103
102   DO 101 J=1,IDPT
103   IF(IDATA(J).EQ.0)GO TO 101
      IF(K4.NE.0)J=1
      IF(DTA(J).EQ.0)DTA(J)=DTA(J)+1
      DTA(J)=1/DTA(J)
101   CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IE,ICUF)
100   CONTINUE
      GO TO 60
2     WRITE(1,4423)
4423  FORMAT (" ENTER THE LARGEST NEG. VALUE AS AN ABSOL. NUMBER:")
      RFAD(1,*) C
      DO 200 K=1,NSUB
      CALL READF(IB,IE,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(K4.EQ.0)GO TO 202
      J=K4
      GO TO 203
202   DO 201 J=1,IDPT
203   IF(IDATA(J).EQ.0)GO TO 201
      IF(K4.NE.0)J=1
      IF(DTA(J).LT.10)DTA(J)=DTA(J)+.5+C
      DTA(J)=(DTA(J)**.5)
201   CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IE,ICUF)
200   CONTINUE
      GO TO 60
3     WRITE(1,4424)
4424  FORMAT (  " ENTER LARGEST NEG. NUMBER AS AN ABSOL. NUMBER :  ")
      READ(1,*)  C
      DO 300 K=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(K4.EQ.0)GO TO 302
      J=K4
      GO TO 303
302   DO 301 J=1,IDPT
303   IF(IDATA(J).EQ.0)GO TO 301
      IF(K4.NE.0)J=1
      DTA(J)=ALOG(DTA(J)+1+C)
301   CONTINUE
```

```
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IE,ICUF)
300   CONTINUE
      GO TO 60
5     WRITE(1,4425)
4425  FORMAT (  " TYPE THE HIGHEST POSITIVE NUMBER :    ")
      READ(1,*)  C
      WRITE(1,4426)
4426  FORMAT ( " TYPE THE HIGHEST NEG. # AS AN ABSOL. NUMBER :    ")
      READ(1,*)  C1
      DO 500 K=1,NSUB
      CALL READF(IB,IRT,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(K4.EQ.0)GO TO 502
      J=K4
      GO TO 503
502   DO 501 J=1,IDPT
503   IF(IDATA(J).EQ.0)GO TO 501
      IF(K4.NE.0)J=1
      DTA(J)=(DTA(J)+C1)/(C+C1+1)
      DTA(J)=(ALOG((1+DTA(J))/(1-DTA(J))))*.5
501   CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IEV,ICUF)
500   CONTINUE
      GO TO 60
6     WRITE(1,4427)
4427  FORMAT (  " TYPE CONSTANT TO BE USED :    ")
      READ(1,*)  C
      DO 600 K=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(K4.EQ.0)GO TO 602
      J=K4
      GO TO 603
602   DO 601 J=1,IDPT
603   IF(IDATA(J).EQ.0)GO TO 601
      IF(K4.NE.0)J=1
      DTA(J)=DTA(J)+C
601   CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IER,ICUF)
600   CONTINUE
      GO TO 60
7     WRITE(1,4428)
4428  FORMAT (  " TYPE CONSTANT TO BE USED :    ")
      READ(1,*)  C
      DO 700 K=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
```

```
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(K4.EQ.0)GO TO 702
      J=K4
      GO TO 703
702   DO 701 J=1,IDPT
703   IF(IDATA(J).EQ.0)GO TO 701
      IF(K4.NE.0)J=1
      DTA(J)=DTA(J)-C
701   CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IER,ICUF)
700   CONTINUE
      GO TO 60
8     WRITE(1,4429)
4429  FORMAT (  " TYPE CONSTANT TO BE USED :    ")
      READ(1,*)  C
      DO 800 K=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(K4.EQ.0)GO TO 802
      J=K4
      GO TO 803
802   DO 801 J=1,IDPT
803   IF(IDATA(J).EQ.0)GO TO 801
      IF(K4.NE.0)J=1
      DTA(J)=DTA(J)*C
801   CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IER,ICUF)
800   CONTINUE
      GO TO 60
9     WRITE(1,960)
960   FORMAT( " TYPE CONSTANT TO BE USED :    ")
      READ(1,*) C
      DO 900 K=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(K4.EQ.0)GO TO 902
      J=K4
      GO TO 903
902   DO 901 J=1,IDPT
903   IF(IDATA(J).EQ.0)GO TO 901
      IF(K4.NE.0)J=1
      DTA(J)=DTA(J)/C
901   CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IER,ICUF)
900   CONTINUE
      GO TO 60
10    DO 1000 K=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
```

```
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(K4.EQ.0)GO TO 1002
      J=K4
      GO TO 1003
1002  DO 1001 J=1,IDPT
1003  IF(IDATA(J).EQ.0)GO TO 1001
      IF(K4.NE.0)J=1
      IF(DTA(J).LE.0.OR.DTA(J).GE.1)GO TO 1010
      DTA(J)=2*ATAN((DTA(J)/(1-DTA(J)))**.5)
1001  CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IER,ICUF)
1000  CONTINUE
      GO TO 60
1010  WRITE(1,951)
951   FORMAT(" DATA MUST BE PROPORTIONAL - RECHECK DATA !!!",    ,"
     1TRANSFORM ABORTED ")
      GO TO 62
4     IF(IFLE.EQ.0)GO TO 450
      IF(IFLE.GT.1)GO TO 420
450   N=0
      SUM=0
      SUM2=0
      WRITE(1,950)
950   FORMAT(" DO YOU WANT THE MEAN CALCUL.  ON ALL DATA POINTS ?",
     1/"  1 = YES ,   0 = NO  ")
      READ (1,*) C
420   DO 400 K=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(C.EQ.0)GO TO 401
      DO 402 J=1,IDPT
      N=N+1
      SUM=SUM+DTA(J)
      SUM2=SUM2+DTA(J)**2
402   CONTINUE
      GO TO 400
401   IF(K4.EQ.0)GO TO 421
      J=K4
      GO TO 422
421   DO 400 J=1,IDPT
422   IF(IDATA(J).EQ.0)GO TO 400
      IF(K4.NE.0)J=1
      N=N+1
      SUM=SUM+DTA(J)
      SUM2=SUM2+DTA(J)**2
400   CONTINUE
      IF(IFLE.EQ.0)GO TO 423
      IFLE=IFLE+1
      IZ(K4)=NSUB
      IF(IFLE.GT.IV)GO TO 423
      GO TO 32
```

```
423   XN=N
      XMEAN=SUM/XN
      SD=SQRT((SUM2-SUM*SUM/XN)/(XN-1.))
      CALL RWNDF(IB)
      IX=IV
      IV=0
      K1=0
      IF(IFLE.EQ.0)GO TO 431
      DO 410 K1=1,IX
      NSUB=IZ(K1)
431   DO 410 K=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
      IF(IFLE.EQ.0)GO TO 433
      J=K1
      GO TO 432
433   DO 411 J=1,IDPT
432   IF(IDATA(J).EQ.0)GO TO 411
      IF(IFLE.NE 0)J=1
      DTA(J)=(DTA(J)-XMEAN)/SD
411   CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
      CALL WRITF(IC,IER,ICUF)
410   CONTINUE
      GO TO 60
11    IV=IDPT
      NSUB=NSU
      IF(IFLE.NE.1) GO TO 63
      N=0
      DO 3256 I=1,IV
      SUM=0.
      SUM2=0.
      WRITE(1,4422) I
      READ(1,*) NSUB
      DO 1027 J=1,NSUB
      N=N+1
      CALL READF(IB,IER,IBUF,256,LEN,N)
      CALL CODE
      READ(IBUF,IFMT) DAT
      SUM=SUM+DAT
      SUM2=SUM2+DAT*DAT
1027  CONTINUE
      XSUB=NSUB
      XBAR=SUM/XSUB
      SD=SQRT((SUM2-SUM*SUM/XSUB)/(XSUB-1.))
      CALL RWNDF(IB)
      DO 1034 J=1,NSUB
      N=N-NSUB+J
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) DAT
      IF(IDATA(I).EQ.0) GO TO 9651
      DAT=(DAT-XBAR)/SD
9651  CALL CODE
```

```
      WRITE(ICUF,IFMT1) DAT
      M=N-NSUB+J
      CALL WRITF(IC,IER,ICUF,0,M)
1034  CONTINUE
3256  CONTINUE
      GO TO 62
63    XSUB=NSUB
      DO 64 I=1,IV
      SUM1(I)=0.
64    SUM3(I)=0.
      DO 65 I=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (DTA(J),J=1,IV)
      DO 66 J=1,IV
      SUM1(J)=SUM1(J)+DTA(J)
      SUM3(J)=SUM3(J)+DTA(J)*DTA(J)
66    CONTINUE
 65   CONTINUE
      DO 67 J=1,IV
      XBR(J)=SUM1(J)/XSUB
67    STD(J)=SQRT((SUM3(J)-SUM1(J)*SUM1(J)/XSUB)/(XSUB-1.))
      CALL RWNDF(IB)
      DO 68 I=1,NSUB
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (DTA(J1),J1=1,IV)
      DO 69 J=1,IV
      IF(IDATA(J).EQ.0) GO TO 69
      DTA(J)=(DTA(J)-XBR(J))/STD(J)
69    CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT1) (DTA(J),J=1,IV)
      CALL WRITF(IC,IER,ICUF,0,I)
68    CONTINUE
      GO TO 62
60    IV=IV-1
      IF(IV.GT.0)GO TO 32
62    CALL CLOSE (IB,IER)
      CALL CLOSE(IC)
      WRITE(1,4567) ITEST
4567  FORMAT(" TRANSFORMATION TYPE ",I5,"  IS FINISHED",/,
     1" TO STOP ENTER 0, FOR MORE ENTER ANY OTHER NUMBER")
      READ(1,*) LTEST
      IF(LTEST.EQ.0) GO TO 61
      GO TO 50
61    STOP
      END
      END$
```

II. PARAMETRIC STATISTICS

A. Descriptive Statistics

DSPD (Parametric Descriptive Statistics)

Purpose:

This program describes parametric data by various statistics including mean, standard deviation, skewness, kurtosis, and range.

User Consideration and Procedures:

1. Data files can either be in matrix form with equal number of variables per subject, or in sequential form, n_j, where n_j equals number of subjects for variables j.

2. For data files in matrix form, the variables per subject constitute a record in the data file. A printout of raw data would show j observations per line (subject). For data files in sequential form, read in all subjects under variable 1, then index to variable 2, etc. Raw data printout shows 1 observation per line.

3. The data can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

4. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#3).

5. Parameters required:

   a. number of variables (maximum 30)

   b. data file name

   c. format and record length of data file

   d. type of data:

      1 for continuous (sequential)
      0 for matrix

   e. for continuous data file - number of subjects for each variable

   f. for matrix data file - number of subjects

6. Printout gives the following information for each variable:

   a. variable number

   b. number of subjects

   c. mean

   d. standard deviation

   e. skewness

   f. kurtosis

   g. range

Test Data:

Program was tested by comparing data output with results obtained from hardwired programmed functions of a Texas Instruments calculator.

```
 RU,DSPD
 NUMBER OF VARIABLES :
8
 INPUT FILENAME
#FATAA
ENTER DATA FORMAT
(8(2X,F6.2))
 ENTER THE RECORD LENGTH AS IN DA3Ø
64
 TYPE OF DATA  1  =  CONTINUOUS , Ø = MATRIX:
Ø
ENTER # OF SUBJECTS
32
 ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT
6
:
```

VARIABLE #	1
NUMBER OF SUBJECTS =	32
MEAN =	42.750
STANDARD DEVIATION =	21.691
SKEWNESS =	.581
KURTOSIS =	-1.204
RANGE =	63.000

VARIABLE #	2
NUMBER OF SUBJECTS =	32
MEAN =	48.812
STANDARD DEVIATION =	23.952
SKEWNESS =	-.170
KURTOSIS =	-1.384
RANGE =	75.000

VARIABLE #	3
NUMBER OF SUBJECTS =	32
MEAN =	342.375
STANDARD DEVIATION =	380.971
SKEWNESS =	1.160
KURTOSIS =	.247
RANGE =	1406.000

VARIABLE #	4
NUMBER OF SUBJECTS =	32
MEAN =	632.781
STANDARD DEVIATION =	464.372
SKEWNESS =	1.544
KURTOSIS =	2.590
RANGE =	2122.000

VARIABLE #	5
NUMBER OF SUBJECTS =	32
MEAN =	616.656
STANDARD DEVIATION =	429.506
SKEWNESS =	1.114
KURTOSIS =	.767
RANGE =	1730.00

VARIABLE #	6
NUMBER OF SUBJECTS =	32
MEAN =	672.687
STANDARD DEVIATION =	543.445
SKEWNESS =	1.776
KURTOSIS =	3.491
RANGE -	2567.000

VARIABLE #	7
NUMBER OF SUBJECTS =	32
MEAN =	565.875
STANDARD DEVIATION =	376.128
SKEWNESS =	.354
KURTOSIS =	-1.256
RANGE =	1264.000

VARIABLE #	8
NUMBER OF SUBJECTS =	32
MEAN =	601.625
STANDARD DEVIATION =	646.360
SKEWNESS =	2.235
KURTOSIS =	5.985
RANGE =	3149.000

```
*DSPD  T=00003 IS ON CR00002 USING 00014 BLKS R=0000

FTN4
        PROGRAM DSPD
        DIMENSION NAME(3)
        DOUBLE PRECISION DAT(30),SUM(30),SUM2(30),SUM3(30),
       XSUM4(30),SMEAN(30),SKEW(30),AKURT(30),SD(30),RH(30),RL(30)
        DIMENSION IB(272),IBUF(256),IFMT(20),NS(30)
        WRITE(1,4400)
  4400  FORMAT ( " NUMBER OF VARIABLES :    ")
        READ(1,*) NV
        WRITE(1,4401)
  4401  FORMAT ( " INPUT FILENAME"   )
        READ(1,1)NAME
  1     FORMAT(3A2)
        WRITE(1,3458)
  3458  FORMAT(" ENTER DATA FORMAT ")
        READ(1,987) IFMT
  987   FORMAT(20A2)
        CALL OPEN(IB,IERR,NAME)
        IF(IERR.GE.0) GO TO 77
        WRITE(1,78) NAMA,IERR
  78    FORMAT(5X,3A2," FAILED TO OPEN ",I5," ERROR #")
        STOP
  77    WRITE(1,4403)
  4403  FORMAT ( " TYPE OF DATA  1 = CONTINIOUS , 0 = MATRIX :    ")
        READ(1,*) ITYP
        IF(ITYP.NE.0) GO TO 99
        WRITE(1,100)
  100   FORMAT( "ENTER # OF SUBJECTS ")
        READ(1,*) NSUB
        GO TO 20
  99    K4=NV
        IF(ITYP.EQ.0)GO TO 20
        K4=NV
        NV=1
        DO 3 J1=1,K4
        WRITE(1,4404) J1
  4404  FORMAT ( " NUMBER OF SUBJECTS FOR VARIABLE #  ",I5 )
        READ(1,*) NSUB
  20    DO 2 K=1,NSUB
        CALL READF(IB,IER,IBUF)
        CALL CODE
        READ(IBUF,IFMT)(DAT(J),J=1,NV)
        IF(K.GT.1)GO TO 10
        DO 11 J=1,NV
        J2=J
        IF(ITYP.EQ.1)J2=J1
        RH(J2)=DAT(J)
  11    RL(J2)=DAT(J)
  10    DO 2 J=1,NV
```

```
      J2=J
      IF(ITYP.EQ.1)J2=J1
      SUM(J2)=SUM(J2)+DAT(J)
      SUM2(J2)=SUM2(J2)+DAT(J)**2
      IF(RH(J2).LT.DAT(J))RH(J2)=DAT(J)
      IF(RL(J2).GT.DAT(J))RL(J2)=DAT(J)
2     CONTINUE
      DO 12 J=1,NV
      J2=J
      IF(ITYP.EQ.1)J2=J1
12    RH(J2)=RH(J2)-RL(J2)+1
      DO 3 J=1,NV
      J2=J
      IF(ITYP.EQ.1)J2=J1
      NS(J2)=NSUB
      SMEAN(J2)=SUM(J2)/NS(J2)
      AA=NS(J2)
3     SD(J2)=(((AA*SUM2(J2))-(SUM(J2)**2))/(AA*(AA-1.)))**.5
      CALL RWNDF(IB)
      IF(ITYP.EQ.0)GO TO 21
      DO 5 J1=1,K4
      NSUB=NS(J1)
21    DO 4 K=1,NSUB
      CALL READF(IB,IERR,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DAT(J),J=1,NV)
      DO 4 J=1,NV
      J2=J
      IF(ITYP.EQ.1)J2=J1
      SUM3(J2)=SUM3(J2)+(DAT(J)-SMEAN(J2))**3
      SUM4(J2)=SUM4(J2)+(DAT(J)-SMEAN(J2))**4
4     CONTINUE
      DO 5 J=1,NV
      J2=J
      IF(ITYP.EQ.1)J2=J1
      SKEW(J2)=SUM3(J2)/(NS(J2)*(SD(J2)**3))
5     AKURT(J2)=(SUM4(J2)/(NS(J2)*(SD(J2)**4)))-3
      IF(ITYP.EQ.1)NV=K4
873   WRITE(1,543)
543   FORMAT(" ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT")
      READ(1,*) IUNIY
      IF((IUNIY.NE.1).AND.(IUNIY.NE.6)) GO TO 873
      WRITE(IUNIY,5431)
5431  FORMAT(" ","VAR#  #SUBJ         MEAN    STD.DEV.",
     C"   SKEWNESS    KURTOSIS        RANGE")
      WRITE(IUNIY,14)((J,NS(J),SMEAN(J),SD(J),SKEW(J),AKURT(J),
     CRH(J)),J=1,NV)
14    FORMAT(" ",I4,2X,I5,2X,F10.3,2X,F10.3,2X,F10.3,2X,F10.3,
     C2X,F10.3)
      CALL CLOSE (IB)
      END
      END$
```

B. Analysis of Variance and Covariance

AV10 (CR-k) (One-way ANOVA)

Purpose:

This program performs a one-way analysis of variance without replication.

Mathematical Model:

The model for this design is:

$$X_{ij} = I + B_j + E_{ij}$$

The hypothesis to be tested is:

$$Ho: \; B_j = 0 \text{ for all } j$$

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

Treatment Levels			
b_1	b_2	b_3	b_k

1. There are k levels of treatment B.

2. Subjects are randomly assigned to the treatment levels with each subject designated to receive only one level.

User Considerations and Procedures:

1. A data file must be created with each data point in a sequential file with group one first, then group two, etc. (For example, subject one for treatment b_1 is first record, subject two for treatment b_1 is second record . . ., then subject one for treatment b_2 . . ., subject n for treatment b_j is last record.) A printout of the raw data file would show only one data point per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of subjects (maximum 32767)

   b. number of groups (maximum 100)

   c. number of subjects in each group (maximum 32767)

   d. name of data file

   e. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

The F-test is analogous to a t-test for uncorrelated data when the design consists of only two treatment levels. The advantage of this ANOVA design is freedom from the restriction of having an equal number of subjects under each level.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 100-105.

The accuracy of the program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

```
 RU,AV1Ø
AV1Ø OR CRK
NOTE:  PROGRAM EXPECTS DATA TO BE IN ONE SEQUENTIAL
           FILE WITH GROUP 1 FIRST THEN GROUP 2, ETC.
NOTE:  MAXIMUM OF 100 GROUPS
ENTER 1 FOR CRT OUTPUT , 6 FOR LPT
6
DO YOU WANT PRINTOUT OF RAW DATA  1 = YES , Ø = NO
1
TOTAL NUMBER OF SUBJECTS?
32
HOW MANY GROUPS?  (maximum 100)
4
ENTER NAME OF INPUT DATA FILE:
#AV2Ø
 ENTER INPUT DATA FORMAT
(4X,F1Ø.4)


ENTER SS/GP BEGINNING WITH GP ONE
   HIT RETURN KEY AFTER EACH ENTRY
8
8
8
8
  AV1Ø  :  STOP    ØØØØ
:
```

GROUP 1 RAW DATA

3.0000
6.0000
3.0000
3.0000
4.0000
5.0000
4.0000
3.0000

GROUP 2 RAW DATA

7.0000
8.0000
7.0000
6.0000
7.0000
8.0000
9.0000
8.0000

GROUP 3 RAW DATA

1.0000
2.0000
2.0000
2.0000
2.0000
3.0000
4.0000
3.0000

GROUP 4 RAW DATA

5.0000
6.0000
5.0000
6.0000
10.0000
9.0000
11.0000
10.0000

GROUP	N	SUMX	SUMX2	MEAN	SD
1	8	31.000	129.000	3.875	1.126
2	8	60.000	456.000	7.500	.926
3	8	19.000	51.000	2.375	.916
4	8	62.000	524.000	7.750	2.493

SOURCE TABLE

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.000			
BETWEEN	171.250	3.000	57.083	24.8768	.00000
WITHIN	64.250	28.000	2.295		

```
*AV10  T=00003 IS ON CR00002 USING 00012 BLKS R=0000

FTN4,L
            PROGRAM AV10
            DOUBLE PRECISION B(80),BSS,XBAR(80),SD(80),DATAX,SX,BS,BB
            DOUBLE PRECISION BBS(80),X,BB,SST,SSBG,SSWG,BDF,WDF,TDF,EMS
            DOUBLE PRECISION WMS,F,Z,PS
            DIMENSION N(80),INFILE(3),IFMT(20)
            DIMENSION IB(272),IBUF(256)
            SX=0.
            BS=0.
            BB=0.
            WRITE(1,4400)
4400        FORMAT ( "AV10 OR CRK",/,
          C "NOTE:  PROGRAM EXPECTS DATA TO BE IN ONE SEQUENTIAL"  ,/,
          C "       FILE WITH GROUP 1 FIRST THEN GROUP 2, ETC.",/,
          C "NOTE:  MAXIMUM OF 80 GROUPS"  ,/,
          C "ENTER 1 FOR CRT OUTPUT , 6 FOR LPT     ")
            READ(1,*) IUNIT
            WRITE(1,4405)
4405        FORMAT ( "DO YOU WANT PRINTOUT OF RAW DATA  1 = YES , 0 = NO")
            READ(1,*)  IPTO
            WRITE(1,4406)
4406        FORMAT ( "TOTAL NUMBER OF SUBJECTS?  ")
            READ(1,*)  NSUB
            WRITE(1,4407)
4407        FORMAT ( "HOW MANY GROUPS? (LIMIT IS 80)    ")
            READ(1,*) NGRP
            WRITE(1,4408)
4408        FORMAT ( "ENTER NAME OF INPUT DATA FILE:  " )
            READ (1,300) INFILE
300         FORMAT (3A2)
            WRITE(1,409)
409         FORMAT("ENTER INPUT DATA FORMAT I.E. (F10.4)    ")
            READ(1,301) IFMT
301         FORMAT(20A2)
            IDCBS=256
            CALL OPEN (IB,IER,INFILE,3,0,-2,IDCBS)
            IF(IER.GE.0) GO TO 870
            WRITE(1,655) INFILE,IER
655         FORMAT(5X,3A2,"  FAILED TO OPEN , IER = &&&",I5)
            STOP 655
870         WRITE(1,4410)
4410        FORMAT ( "ENTER SUBJECTS/GROUP BEGINNING WITH GROUP ONE"  ,/,
          C  "HIT RETURN KEY AFTER EACH ENTRY" )
            DO 3 J=1,NGRP
3           READ(1,*)  N(J)
90          FORMAT(/," GROUP",3X,"N ",7X,"SUMX",8X,"SUMX2",9X,"MEAN",
          $11X,"SD")
            DO 5 J=1,NGRP
            LL=N(J)
            IF(IPTO.EQ.1)WRITE(IUNIT,2)J
2           FORMAT(" GROUP   ",I2,"   RAW DATA")
            DO 4 K=1,LL
            CALL READF(IB,IER,IBUF)
            CALL CODE
```

```
      READ (IBUF,IFMT) DATAX
      IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)DATAX
      SX=SX+DATAX
      BS=BS+DATAX**2
      BBS(J)=BBS(J)+DATAX**2
4     B(J)=B(J)+DATAX
      XBAR(J)=B(J)/N(J)
      SD(J)=DSQRT((BBS(J)-(B(J)**2)/N(J))/(N(J)-1))
5     CONTINUE
      WRITE(IUNIT,90)
      DO 50 J=1,NGRP
50    WRITE (IUNIT,100)J,N(J),B(J),BBS(J),XBAR(J),SD(J)
100   FORMAT(1X,I3,3X,I3,4(3X,F10.3))
      X=(SX**2)/NSUB
      DO 6 L=1,NGRP
6     BB=BB+((B(L)**2)/N(L))
      SST=BS-X
      SSBG=BB-X
      SSWG=BS-BB
      BDF=NGRP-1
      WDF=NSUB-NGRP
      TDF=NSUB-1
      BMS=SSBG/BDF
      WMS=SSWG/WDF
      F=BMS/WMS
      CALL FPROB (F,BDF,WDF,Z,PS)
      WRITE(IUNIT,875)
875   FORMAT(//,15X,"SOURCE TABLE ",/)
      WRITE (IUNIT,200) SST,TDF,SSBG,BDF,BMS,F,PS,SSWG,WDF,WMS
200   FORMAT (/,"  SOURCE              SS            DF",10X,
     $"MS               F             P"
     $//,"  TOTAL     ",2F13.3,
     $/,"  BETWEEN  ",3F13.3,2X,F11.4,2X,F9.5,/,
     $"  WITHIN   ",3F13.3)
      CALL CLOSE (IB,IER)
      STOP
      END
      END$
```

AV11 (RB-k) (One-way ANOVA, Repeated Measures)

Purpose:

This program performs a one-way analysis of variance with replication either by using matched subjects or repeated measures.

Mathematical Model:

The model for this design is:

$$X_{ij} = u + B_j + \pi_i + E_{ij}$$

The hypothesis to be tested is:

$$Ho: B_j = 0 \text{ for all } j$$

The fixed effect model (Model I) was assumed in the deviation of the expected values of the mean squares.

Layout of Design:

Treatment Levels			
b_1	b_2	b_3	b_k

1. There are k levels of treatment B.

2. Subjects are assigned to a treatment so that variability within a treatment is less than the variability among treatments. Homogeneity within treatments may be achieved by using a subject as his own control or by using subjects matched on the basis of a variable that correlates with the dependent variable.

User Considerations and Procedures:

1. A data file must be created with each data point in a matrix file. On input, index for within factor varies most rapidly. (For example, first record is subject one, treatment b_1, subject one, treatment b_2 . . . , subject one, treatment b_k ; second record subject two, treatment b_1, subject two, treatment b_2 . . . , subject two, treatment b_k . . .; the last record is subject n, treatment b_1, subject n, treatment b_2 . . . , subject n, treatment b_k.) A printout of the raw data file would show k data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of subjects (maximum 32767)

   b. number of groups (maximum 100)

   c. number of subjects in each group (maximum 32767)

   d. name of file

   e. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

The F-test is analogous to a t-test for correlated data when the design consists of only two treatment levels. This ANOVA design permits an experimenter to minimize the effects of individual differences. However, the design requires that the population covariances for all pairs of treatment levels be homogeneous.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 132-134.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for the Social Sciences.

```
 RU,AV11
AV11 OR RBK
  *** ONE WAY ANOVA FOR REPEATED MEASURES ***
     NOTE:  DATA INPUT READ SEQUENCE, INDEX FOR WITHIN
            FACTOR VARIES MOST RAPIDLY.  PROGRAM EXPECTS ALL
            DATA TO BE IN ONE MATRIX FILE.
     NOTE:  MAXIMUM OF 100 TREATMENTS (WITHIN FACTOR)
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , Ø = NO
1
ENTER # SS/GP
8
ENTER # LEVELS FOR TREATMENTS:
4
ENTER NAME OF DATA FILE:
#AV11


ENTER FORMAT OF DATA:
(4(4X,F1Ø.4))
:
```

RAW DATA

3.0000	7.0000	4.0000	7.0000
6.0000	8.0000	5.0000	8.0000
3.0000	7.0000	4.0000	9.0000
3.0000	6.0000	3.0000	8.0000
1.0000	5.0000	2.0000	10.0000
2.0000	6.0000	3.0000	10.0000
2.0000	5.0000	4.0000	9.0000
2.0000	6.0000	3.0000	11.0000

TREATMENT	N	SUMX	SUMX2	MEAN	SD
1	8	22.000	76.000	2.750	1.488
2	8	50.000	320.000	6.250	1.035
3	8	28.000	104.000	3.500	.926
4	8	72.000	660.000	9.000	1.309

SOURCE TABLE

SOURCE	SS	DF	MS	F	P
TOTAL	235.50000	31.			
TREATMENT	194.5000	3.	64.8333	47.7719	.00000
SUBJECTS	12.5000	7.	1.7857	1.3158	.29097
RESIDUAL	28.5000	21.	1.3571		

```
*AV11  T=00003 IS ON CR00002 USING 00014 BLKS R=0000

FTN4,L
            PROGRAM AV11
            DIMENSION IFMT(20),INFILE(3)
            DOUBLE PRECISION S2(80),DMTX(80),XS2(80),S3,S4,S8,CT,SST
            DOUBLE PRECISION SSS,S11,S3TR,SSER,XBAR(80),SD(80)
            DOUBLE PRECISION RMSS,RMSTR,RMSER,FS,FTR,TEMP
            DOUBLE PRECISION DFT,DFS,DFTR,DFER,DF1,DF2,F,Z,PS
            DIMENSION IB(272),IBUF(256)
            WRITE(1,4400)
4400        FORMAT ( "$AV11 OR RBK" ,/,
          C"   *** ONE WAY ANOVA FOR REPEATED MEASURES ***"  ,//,
          C"  NOTE:  DATA INPUT READ SEQUENCE, INDEX FOR WITHIN",/,
          C"          FACTOR VARIES MOST RAPIDLY.  PROGRAM EXPECTS ALL",/,
          C"          DATA TO BE IN ONE MATRIX FILE." ,/,
          C"  NOTE:  MAXIMUM OF 80 TREATMENTS WITHIN FACTOR   " ,//,
          C"ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: ")
            READ(1,*)  IUNIT
            WRITE(1,4409)
4409        FORMAT("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO   ")
            READ(1,*)  IPTO
            WRITE(1,4410)
4410        FORMAT ( "ENTER # SUBJECTS/GROUP  ")
            READ(1,*) NS
            WRITE(1,4411)
4411        FORMAT ( "ENTER # LEVELS FOR TREATMENTS: ")
            READ(1,*)  NLV
            WRITE(1,4412)
4412        FORMAT ( "ENTER NAME OF DATA FILE:" )
            READ(1,106)INFILE
106         FORMAT(3A2)
            IDCBS=256
            CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
            IF(IER.GE.0)GO TO 101
            WRITE(1,4413) INFILE,IER
4413        FORMAT(5X,3A2,5X,"DATA FILE FAILED TO OPEN, IER = ",I5 )
            STOP 4413
101         WRITE(1,4414)
4414        FORMAT (  "ENTER FORMAT OF DATA: I.E. (4F10.4)  ")
            READ(1,102)IFMT
102         FORMAT(20A2)
            IF(IPTO.EQ.1)WRITE(IUNIT,1)
1           FORMAT(" RAW DATA")
            DO 20 K=1,NS
            CALL READF(IB,IER,IBUF,IDCBS)
            CALL CODE
```

```
      READ(IBUF,IFMT)(DMTX(J),J=1,NLW)
      IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)(DMTX(J),J=1,NLW)
      TEMP=0
      DO 10 I=1,NLW
      NM=NM+1
      S2(I)=S2(I)+DMTX(I)
      XS2(I)=XS2(I)+DMTX(I)**2
      S3=S3+DMTX(I)**2
      S4=S4+DMTX(I)
      TEMP=TEMP+DMTX(I)
10    CONTINUE
      S8=S8+TEMP**2
20    CONTINUE
      CT=S4**2/NM
      SST=S3-CT
      SSS=(S8/NLW)-CT
      DO 30 I=1,NLW
      XBAR(I)=S2(I)/NS
30    S11=S11+S2(I)**2
      S11=S11/NS
      SSTR=S11-CT
      SSER=SST-SSS-SSTR
      DFT=NM-1
      DFS=NS-1
      DFTR=NLW-1
      DFER=DFT-DFS-DFTR
      RMSS=SSS/DFS
      RMSTR=SSTR/DFTR
      RMSER=SSER/DFER
      FS=RMSS/RMSER
      FTR=RMSTR/RMSER
      DF1=DFS
      DF2=DFER
      F=FS
      CALL FPROB(F,DF1,DF2,Z,PS)
      DF1=DFTR
      DF2=DFER
      F=FTR
      CALL FPROB(F,DF1,DF2,Z,PTR)
      DO 50 I=1,NLW
      ANS=NS
50    SD(I)=DSQRT((ANS*XS2(I)-(S2(I)**2))/(ANS*(ANS-1.)))
      WRITE(IUNIT,51)(I,NS,S2(I),XS2(I),XBAR(I),SD(I),I=1,NLW)
51    FORMAT(//," TREATMENT        N         SUMX         SUMX2
     $  MEAN          SD",//,
     $(I7,8X,I3,4X,F10.3,2X,F10.3,2X,F10.3,2X,F10.3))
      WRITE(IUNIT,105)SST,DFT,SSTR,DFTR,RMSTR,FTR,PTR,SSS,DFS,RMSS,
     $FS,PS,SSER,DFER,RMSER
105   FORMAT(///,15X,"SOURCE TABLE ",///,X,"SOURCE ",12X,"SS",9X,
     $"DF",11X,"MS",11X,"F",10X,"P",//," TOTAL",9X,F12.4,1X,F6.0,
     #/," TREATMENT   ",2X,F12.4,1X,F6.0,3X,F12.4,3X,F10.4,3X,
     %F6.5,/," SUBJECTS  ",4X,F12.4,1X,F6.0,3X,F12.4,3X,F10.4,3X,
     &F6.5,/," RESIDUAL  ",4X,F12.4,1X,F6.0,3X,F12.4)
      CALL CLOSE(IB)
      END
      END$
```

AV20 (CRF-P,Q) (Two-way ANOVA)

Purpose:

This program performs a two-way completely randomized facotrial analysis of variance without replication.

Mathematical Model:

The model for this design is:

$$X_{ijm} = u + A_i + B_j + AB_{ij} + E_{m(ij)}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $AB_{ij} = 0$ for all ij

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A_1		A_2		A_3	
B_1	B_2	B_1	B_2	B_1	B_2
S_1	S_2	S_3	S_4	S_5	S_6

S represents a set of subjects

1. There are two factors (A,B) with p and q levels of treatments respectively. The experiment consists of pq treatment combinations. The above example includes three levels of Factor A, two levels of Factor B.

2. Subjects are randomly assigned to the pq treatment combinations, with each subject receiving only one combination.

3. There should be more than one subject per pq treatment combinations.

User Considerations and Procedures:

1. A data file must be created with each data point in a sequential file. On input, Factor B varies most rapidly, then Factor A. (For example, first record is subject one for treatment ab_{11}, second record subject two, treatment ab_{11} . . ., then subject one treatment ab_{12}, next is subject two, ab_{12} . . ., then subject one treatment ab_{21} . . ., final record would be subject n for treatment ab_{pq}.) A printout of the raw data file would show one data point per line.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if a raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of Factor A (maximum 30)

   b. number of levels of Factor B (maximum 30)

   c. number of subjects per AB cell (maximum 32767)

   d. name of data file

   e. format of data file

5. Printout gives:

   a. raw data (option)

   b. for each cell: Σ, Σx^2, $\overline{X}$, SD (unbiased estimate)

   c. ANOVA source table

Comments:

Program uses least square analysis for unequal cell sample sizes. This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, _Experimental Design Procedures for the Behavioral Sciences_, Wadsworth Publishing Company, 1968, Pp. 175-176.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

```
 RU,AV2Ø
AV2Ø OR CRFPQ
REF: BRUNING & KINTZ, 1968
SECTION 2.2
FACTORIAL DESIGN:   TWO FACTORS
     NOTE:  PROGRAM CALCULATES LEAST SQUARES
            SOLUTION IF UNEQUAL CELL N'S
     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX
            FOR FACTOR B VARIES MOST
            RAPIDLY.  PROGRAM EXPECTS DATA TO BE IN
            ONE SEQUENTIAL FILE.
     NOTE:  MAX 30 * 30  DESIGN
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
DO YOU WANT TO PRINT OUT OF RAW DATA 1 = YES , Ø = NO
1
ENTER INPUT DATA FILE NAME:
#AV2Ø


ENTER INPUT DATA FORMAT:
(4X,F1Ø.4)
ENTER # LEVELS ON FACTOR A & B:
2,4
FACTOR A, LEVEL:        1
FACTOR B, LEVEL:        1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:        1
FACTOR B, LEVEL:        2
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:        1
FACTOR B, LEVEL:        3
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:        1
FACTOR B, LEVEL:        4
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:        2
FACTOR B, LEVEL:        1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:        2
FACTOR B, LEVEL:        2
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:        2
FACTOR B, LEVEL:        3
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:        2
FACTOR B, LEVEL:        4
ENTER # SS THIS CELL:
4
:
```

GROUP 1 1 RAW DATA
3.0000
6.0000
3.0000
3.0000
GROUP 1 2 RAW DATA
4.0000
5.0000
4.0000
3.0000
GROUP 1 3 RAW DATA
7.0000
8.0000
7.0000
6.0000
GROUP 1 4 RAW DATA
7.0000
8.0000
9.0000
8.0000
GROUP 2 1 RAW DATA
1.0000
2.0000
2.0000
2.0000
GROUP 2 2 RAW DATA
2.0000
3.0000
4.0000
3.0000
GROUP 2 3 RAW DATA
5.0000
6.0000
5.0000
6.0000
GROUP 2 4 RAW DATA
10.0000
9.0000
11.0000
10.0000

CELL	N	SUMX	SUMX2	MEAN	SD
1 1	4	15.000	63.000	3.750	1.500
1 2	4	16.000	66.000	4.000	.816
1 3	4	28.000	198.000	7.000	.816
1 4	4	32.000	258.000	8.000	.816
2 1	4	7.000	13.000	1.750	.500
2 2	4	12.000	38.000	3.000	.816
2 3	4	22.000	122.000	5.500	.577
2 4	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
FACTOR A	3.125	1.	3.125	4.054	.052693
FACTOR B	194.500	3.	64.833	84.108	.000000
A * B	19.375	3.	6.458	8.378	.000788
ERROR	18.500	24.	.771		

```
*AV20  T=00003 IS ON CR00002 USING 00018 BLKS R=0000

FTN4,L
      PROGRAM AV20
      DOUBLE PRECISION SX2(20,20),S2(20,20),S6(20),S7(20),RDATA
      DOUBLE PRECISION S3,S4,CT,SST,SSA,SSB,PAB,PB
      DOUBLE PRECISION SSAB,SSER,MSB,MSA,MSAB,MSER,FA,FB,FAB
      DOUBLE PRECISION TSS,XBAR,DFT,DFA,DFB,DFAB,DFER,F,DF1,DF2,Z,PA
      DIMENSION IB(272),IBUF(256)
      DIMENSION NS(20,20),IFMT(20),NS6(20),NS7(20)
      DIMENSION INFILE(3)
      WRITE(1,4400)
4400  FORMAT ( "AV20 OR CRFPQ&" ,/,
     C "REF: BRUNING & KINTZ, 1968" ,/,
     C "SECTION 2.2"  ,/,
     C "FACTORIAL DESIGN:  TWO FACTORS" ,/,
     C "     NOTE:  PROGRAM CALCULATES LEAST SQUARES" ,/,
     C "     SOLUTION IF UNEQUAL CELL N'S" ,)
      WRITE(1,4401)
4401  FORMAT("     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX" ,/,
     C "     FOR FACTOR B VARIES MOST" ,/,
     C "     RAPIDLY.  PROGRAM EXPECTS DATA TO BE IN"  ,/,
     C "     ONE SEQUENTIAL FILE." ,/,
     C "     NOTE:  MAX 20 * 20 DESIGN" ,//)
290   WRITE(1,4411)
4411  FORMAT (  "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: ")
      READ(1,*)  IUNIT
      IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 290
      WRITE(1,4412)
4412  FORMAT("DO YOU WANT TO PRINT OUT OF RAW DATA 1= YES , 0= NO")
      READ(1,*) IPTO
      WRITE(1,4413)
4413  FORMAT ( "ENTER INPUT DATA FILE NAME:"  )
      READ(1,194)INFILE
194   FORMAT(3A2)
191   FORMAT(20A2)
      IDCBS=256
      IF(LENGTH.LT.144) IDCBS=144
      CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
      IF(IER.GE.0)GO TO 19155
      WRITE(1,4414) IER
4414  FORMAT ( "NO OPEN INPUT DATA FILE, IER = "I5  )
      STOP
19155 WRITE(1,4415)
4415  FORMAT (  "ENTER INPUT DATA FORMAT: I.E. (F10.4)"  )
      READ(1,191)IFMT
      WRITE(1,4416)
4416  FORMAT ( "ENTER # LEVELS ON FACTOR A & B:  ")
      READ(1,*) NLA,NLB
      NGPS=NLA*NLB
      DO 1915 LA=1,NLA
      DO 1915 LB=1,NLB
      WRITE(1,4417) LA
```

```
4417  FORMAT ( "FACTOR A, LEVEL: ",I5 )
      WRITE(1,4418) LB
4418  FORMAT ( "FACTOR B, LEVEL: ",I5 )
      WRITE(1,4419)
4419  FORMAT ( "ENTER # SUBJECTS THIS CELL:  ")
      READ(1,*) NS(LA,LB)
      K=NS(LA,LB)
      TSS=TSS+K
      IF(IPTO.EQ.1)WRITE(IUNIT,2)LA,LB
2     FORMAT(" GROUP   ",2I3,"   RAW DATA")
      DO 1914 N=1,K
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)RDATA
      IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)RDATA
      S2(LA,LB)=S2(LA,LB)+RDATA
      S3=S3+RDATA**2
      S4=S4+RDATA
      S6(LA)=S6(LA)+RDATA
      S7(LB)=S7(LB)+RDATA
      NS6(LA)=NS6(LA)+1
      NS7(LB)=NS7(LB)+1
      SX2(LA,LB)=SX2(LA,LB)+RDATA**2
1914  CONTINUE
1915  CONTINUE
      WRITE(IUNIT,3004)
      DO 3005 I1=1,NLA
      DO 3005 I2=1,NLB
      XBAR=S2(I1,I2)/NS(I1,I2)
      ANS=NS(I1,I2)
      SD=DSQRT((ANS*SX2(I1,I2)-S2(I1,I2)**2)/
     $(ANS*(ANS-1.)))
3005  WRITE(IUNIT,301)I1,I2,NS(I1,I2),S2(I1,I2),SX2(I1,I2),XBAR,SD
3004  FORMAT("0   CELL      N          SUMX       SUMX2        MEAN"
     $,"        SD")
301   FORMAT(2X,2I3,3X,I4,3X,4(1X,F10.3))
      CT=S4**2/TSS
      SST=S3-CT
      DO 699 LA=1,NLA
699   SSA=SSA+S6(LA)**2/NS6(LA)
      SSA=SSA-CT
      DO 799 LB=1,NLB
799   SSB=SSB+S7(LB)**2/NS7(LB)
      SSB=SSB-CT
      DO 899 LA=1,NLA
      DO 899 LB=1,NLB
899   SSAB=SSAB+S2(LA,LB)**2/NS(LA,LB)
      SSAB=SSAB-SSA-SSB-CT
      SSER=SST-SSA-SSB-SSAB
      DFT=TSS-1
      DFA=NLA-1
      DFB=NLB-1
      DFAB=DFA*DFB
      DFER=DFT-DFA-DFB-DFAB
      MSA=SSA/DFA
      MSB=SSB/DFB
      MSAB=SSAB/DFAB
      MSER=SSER/DFER
```

```
      FA=MSA/MSER
      FB=MSB/MSER
      FAB=MSAB/MSER
      F=FA
      DF1=DFA
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PA)
      F=FB
      DF1=DFB
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PB)
      F=FAB
      DF1=DFAB
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PAB)
      WRITE(IUNIT,1299)SST,DFT,SSA,DFA,MSA,FA,PA,SSB,DFB,MSB,FB,PB,
     $SSAB,DFAB,MSAB,FAB,PAB,SSER,DFER,MSER
 1299 FORMAT("0  SOURCE",8X,"SS",5X,"DF",6X,"MS",9X,"F",11X,"P"//
     $" TOTAL",6X,F10.3,F5.0/3X,"FACTOR A ",F10.3,F5.0,2F10.3,F10.6/
     $3X,"FACTOR B ",F10.3,F5.0,2F10.3,F10.6/3X,"A * B",4X,F10.3,
     $F5.0,2F10.3,F10.6,/5X,"ERROR  ",F10.3,F5.0,F10.3)
      CALL CLOSE(IB,IER)
        END
        END$
```

AV21B (SPF-P.Q) (Two-way Split Plot ANOVA, Repeated Measures)

Purpose:

This program performs a two-way split-plot or mixed analysis of variance.

Mathematical Model:

The model for this design is:

$$X_{ijm} = u + A_i + B_j + AB_{ij} + \pi_{m(i)} + B\pi_{jm(i)} + E_{o(ijm)}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $AB_{ij} = 0$ for all ij

The mixed effect model (Model III) was used in the derivation of the expected values of the mean squares.

Layout of Design:

	B_1	B_2	B_3
A_1	S_1	S_1	S_1
A_2	S_2	S_2	S_2

S represents a set of subjects

1. There are two Factors (A and B) with p, q levels of treatments respectively. Factor A is designated as the between block or nonrepeated measure. Factor B is the within block repeated measure. The above example includes two levels of Factor A, three levels of Factor B.

2. Subjects from a common population are randomly assigned to the levels of Factor A. After this, levels of treatment B are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.

User Considerations and Procedures:

1. A matrix data file must be created with all data points for each subject in one record. On read input, the within Factor B varies fastest, then Factor A. (For example, record one contains subject 1, cell ab_{11}, ab_{12} . . ., ab_{1q}; second record is subject 2, ab_{11}, ab_{12} . . ., ab_{1q}; etc. Repeat the same procedure for subjects in Factor A_p.) A printout of the raw data would show q data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of between Factor A (maximum 25)

   b. number of levels of within Factor B (maximum 25)

   c. number of subjects per AB cell (maximum 32767)

   d. name of data file

   e. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

Program uses least squares analysis for unequal cell sizes on Factor A. This ANOVA design permits interaction effects to be evaluated. In a split-plot design, estimates of the within block (Factor B and interaction AB) effects are more accurate than estimates of between block (Factor A) effects. If an experimenter's primary interest is in the within-block effects, a split-plot design is more powerful than a randomized factorial block design (AV22). However, if equal precision for all treatment effects is desired, the <u>average</u> power of a randomized factorial block design is greater. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, _Experimental Design Procedures for the Behavioral Sciences_, Wadsworth Publishing Company, 1968, Pp. 249-251.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

```
 RU,AV21B
AV21B OR SPFPQ
REF: BRUNING & KINTZ, 1968
SECTION 2.7
TWO FACTOR MIXED DESIGN:  REPEATED MEASURES ON ONE FACTOR
     NOTE:  PROGRAM CALCULATES LEAST SQUARES SOLUTION
            IF UNEQUAL CELL N'S
     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR
            WITHIN FACTOR (B) VARIES MOST RAPIDLY.
            PROGRAM EXPECTS ALL DATA TO BE IN
            ONE MATRIX FILE.
     NOTE:  MAX 25B * 25W DESIGN
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:
6
DO YOU WANT TO PRINT OUT DATA 1 = YES , Ø = NO
1
ENTER INPUT DATA FILE NAME:
#AV11


ENTER INPUT DATA FORMAT:
(4(4X,F1Ø.4))
ENTER # LEVELS FOR BETWEEN FACTOR (MAX 25):
2
ENTER # LEVELS FOR WITHIN FACTOR (MAX 25):
4
GROUP NUMBER:     1
ENTER NUMBER OF SUBJECTS IN THIS GROUP:
4
GROUP NUMBER:     2
ENTER NUMBER OF SUBJECTS IN THIS GROUP:
4
:
```

GROUP: 1 RAW DATA

3.000	7.000	4.000	7.000
6.000	8.000	5.000	8.000
3.000	7.000	4.000	9.000
3.000	6.000	3.000	8.000

GROUP: 2 RAW DATA

1.000	5.000	2.000	10.000
2.000	6.000	3.000	10.000
2.000	5.000	4.000	9.000
2.000	6.000	3.000	11.000

CELL	N	SUMX	SUMX2	MEAN	STD DEV
1 1	4	15.000	63.000	3.750	1.500
1 2	4	28.000	198.000	7.000	.816
1 3	4	16.000	66.000	4.000	.816
1 4	4	32.000	258.000	8.000	.816
2 1	4	7.000	13.000	1.750	.500
2 2	4	22.000	122.000	5.500	.577
2 3	4	12.000	38.000	3.000	.816
2 4	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
BETWEEN	12.500	7.			
FACTOR A	3.125	1.	3.125	2.000	.205762
ERROR BTW	9.375	6.	1.562		
WITHIN	223.000	24.			
FACTOR B	194.500	3.	64.833	127.890	.000000
A * B	19.375	3.	6.458	12.740	.000228
ERROR W/IN	9.125	18.	.507		

```
*AV21B T=00004 IS ON CR00002 USING 00023 BLKS R=0192

FTN4,L
        PROGRAM AV21B
        DOUBLE PRECISION DVECTR(20),SASX(20),SASX2(20),SS(20)
        DOUBLE PRECISION MSC,MSERRB,MSTR,MSTRXC,FC,FTR,Z,PC,PTR,PTRXC
        DOUBLE PRECISION DSX(20,20),DSX2(20,20),GSX2(20),GSX(20)
        DOUBLE PRECISION TEMP,TSX2,CT,SST,SSC,SSB,SSW,FTRXC,F,DF1,DF2
        DOUBLE PRECISION MSERRW,GT,SSTRXC,SSTR,DFTRXC,DFSERW
        DOUBLE PRECISION SIG(20,20),SAXS2(20),XBAR(20,20),TNS,SSERRB
        DOUBLE PRECISION SSERRW,DFSB,DFST,DFSC,DFSERB,DFSW,DFSTR
        DIMENSION IB(272),IBUF(256),IFILE(3),NSS(20),IFMT(20)
        WRITE(1,4400)
4400    FORMAT ( "AV21B OR SPFPQ" ,/,
       C "REF: BRUNING & KINTZ, 1968" ,/,
       C "SECTION 2.7"  ,/,
       C"TWO FACTOR MIXED DESIGN: REPEATED MEASURES ON ONE FACTOR",/,
       C"     NOTE:  PROGRAM CALCULATES LEAST SQUARES SOLUTION",/,
       C "              IF UNEQUAL CELL N'S"  )
        WRITE(1,4406)
4406    FORMAT ( "     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR",/,
       C "              WITHIN FACTOR (B) VARIES MOST RAPIDLY." ,/,
       C "              PROGRAM EXPECTS ALL DATA TO BE IN"  ,/,
       C "              ONE MATRIX FILE." ,/,
       C "     NOTE:  MAX 20B * 20W DESIGN" )
1       WRITE(1,4411)
4411    FORMAT (  "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:   ")
        READ(1,*) IUNIT
        IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 97
        WRITE(1,4412)
4412    FORMAT ( "DO YOU WANT TO PRINT OUT DATA 1 = YES , 0 = NO    ")
        READ(1,*)  IPTO
        WRITE(1,4413)
4413    FORMAT ( "ENTER INPUT DATA FILE NAME:"  )
        READ(1,85)IFILE
85      FORMAT(3A2)
        IDCBS=256
        CALL OPEN(IB,IER,IFILE,3,0,-2,IDCBS)
        IF(IER.LT.0)GO TO 98
        WRITE(1,4414)
4414    FORMAT ( "ENTER INPUT DATA FORMAT I.E. (4F10.4)" )
        READ(1,80)IFMT
80      FORMAT(20A2)
        WRITE(1,4415)
4415    FORMAT ( "&ENTER # LEVELS FOR BETWEEN FACTOR (MAX 20):   ")
        READ(1,*) NGPS
        WRITE(1,4416)
4416    FORMAT ( "&ENTER # LEVELS FOR WITHIN FACTOR (MAX 20):   ")
        READ(1,*) NLW
        DO 19 NG=1,NGPS
        WRITE(1,4417) NG
4417    FORMAT ( "GROUP NUMBER: ",I5  )
        WRITE(1,4418)
4418    FORMAT ( "ENTER NUMBER OF SUBJECTS IN THIS GROUP:  ")
        READ(1,*) ISS
```

```
      TNS=TNS+ISS
      NSS(NG)=ISS
      IF(IPTO.EQ.1)WRITE(IUNIT,2)NG
2     FORMAT(" GROUP:   ",I3,"   RAW DATA")
      DO 10 J2=1,ISS
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DVECTR(J1),J1=1,NLW)
      TEMP=0.
      IF(IPTO.EQ.1)WRITE(IUNIT,9)(DVECTR(J3),J3=1,NLW)
9     FORMAT(10F9.3)
      DO 7 J1=1,NLW
      TEMP=TEMP+DVECTR(J1)
      SASX(NG)=SASX(NG)+DVECTR (J1)
      SASX2(NG)=SASX2(NG)+DVECTR(J1)**2
      DSX(NG,J1)=DSX(NG,J1)+DVECTR(J1)
      DSX2(NG,J1)=DSX2(NG,J1)+DVECTR(J1)**2
7     CONTINUE
      SAXS2(NG)=SAXS2(NG)+TEMP**2
10    CONTINUE
      SS(NG)=NSS(NG)
      DO 11 J1=1,NLW
      XBAR(NG,J1)=DSX(NG,J1)/SS(NG)
      SIG(NG,J1)=DSQRT((SS(NG)*DSX2(NG,J1)-DSX(NG,J1)**2)/
     $(SS(NG)*(SS(NG)-1)))
      GSX(NG)=GSX(NG)+DSX(NG,J1)
      GSX2(NG)=GSX2(NG)+DSX2(NG,J1)
11    CONTINUE
19    CONTINUE
      WRITE (IUNIT,1904)
1904  FORMAT(/"  CELL     N      SUMX       SUMX2       MEAN      ",
     C"STD DEV")
      DO 191 J1=1,NGPS
1905  FORMAT(2I3,I6,4F10.3)
      WRITE(IUNIT,1905)(J1,J5,NSS(J1),DSX(J1,J3),DSX2(J1,J5),
     $XBAR(J1,J5),SIG(J1,J5),J5=1,NLW)
191   CONTINUE
      DO 1915 J1=1,NGPS
      TSX2=TSX2+GSX2(J1)
1915  GT=GT+GSX(J1)
      CT=GT**2/(TNS*NLW)
      SST=TSX2-CT
      DO 1916 J1=1,NGPS
      SSC=SSC+GSX(J1)**2/(SS(J1)*NLW)
1916  SSB=SSB+SAXS2(J1)
      SSB=SSB/NLW-CT
      SSC=SSC-CT
      SSERRB=SSB-SSC
      SSW=SST-SSB
      TEMP=0
      DO 1976 J1=1,NLW
      DO 1975 K1=1,NGPS
      SSTRXC=SSTRXC+DSX(K1,J1)**2/SS(K1)
1975  TEMP=TEMP+DSX(K1,J1)
      TEMP=TEMP**2/TNS
      SSTR=SSTR+TEMP
1976  TEMP=0.
```

```
      SSTR=SSTR-CT
      SSTRXC=SSTRXC-SSC-SSTR-CT
      SSERRW=SSW-SSTR-SSTRXC
      DO 199 J1=1,NGPS
      DFSB=DFSB+SS(J1)
199   DFST=DFST+SS(J1)
      DFST=DFST*NLW-1
      DFSB=DFSB-1
      DFSC=NGPS-1
      DFSERB=DFSB-DFSC
      DFSW=DFST-DFSB
      DFSTR=NLW-1
      DFTRXC=DFSTR*DFSC
      DSFERW=DFSW-DFSTR-DFTRXC
      MSC=SSC/DFSC
      MSERRB=SSERRB/DFSERB
      MSTR=SSTR/DFSTR
      MSTRXC=SSTRXC/DFTRXC
      MSERRW=SSERRW/DSFERW
      FC=MSC/MSERRB
      FTR=MSTR/MSERRW
      FTRXC=MSTRXC/MSERRW
      F=FC
      DF1=DFSC
      DF2=DFSERB
      CALL FPROB(F,DF1,DF2,Z,PC)
      F=FTR
      DF1=DFSTR
      DF2=DSFERW
      CALL FPROB(F,DF1,DF2,Z,PTR)
      F=FTRXC
      DF1=DFTRXC
      DF2=DSFERW
      CALL FPROB(F,DF1,DF2,Z,PTRXC)
20    FORMAT("0    SOURCE           SS      DF          MS        F      ",
     C"    P",//" TOTAL",
     $9X,F10.3,F5.0/"   BETWEEN      ",F10.3,F5.0/"      FACTOR A  "
     $,F10.3,F5.0,2F10.3,F10.6/"      ERROR BTW ",F10.3,F5.0,F10.3//
     $"   WITHIN",6X,F10.3,F5.0/5X,"FACTOR B  ",F10.3,F5.0,2F10.3,
     $F10.6,/,5X,"A * B",5X,F10.3,F5.0,2F10.3,F10.6/5X,"ERROR W/IN",
     $F10.3,F5.0,F10.3)
      WRITE(IUNIT,20)SST,DFST,SSB,DFSB,SSC,DFSC,MSC,FC,PC,SSERRB,
     $DFSERB,
     $MSERRB,SSW,DFSW,SSTR,DFSTR,MSTR,FTR,PTR,SSTRXC,DFTRXC,MSTRXC,
     $FTRXC,PTRXC,SSERRW,DSFERW,MSERRW
      CALL CLOSE(IB,IER)
      GO TO 834
98    WRITE(1,4420) IER
4420  FORMAT ( "INPUT DATA FILE FAILED TO OPEN, ERROR CODE: ",I5 )
      STOP
97    WRITE(1,4421)
4421  FORMAT ( "INVALID OUTPUT UNIT #"   )
      GO TO 1
834   END
      END$
```

AV22 (RBF-P,Q) (Two-way ANOVA, Repeated Measures)

Purpose:

This program performs a two-way randomized block factorial analysis of variance with replication either by using matched subjects or repeated measures with one subject.

Mathematical Model:

The model for this design is:

$$X_{ijm} = u + A_i + B_j + AB_{ij} + \pi_m + E_{ijm}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $AB_{ij} = 0$ for all ij

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A_1		A_2		A_3	
B_1	B_2	B_1	B_2	B_1	B_2
S_1	S_1	S_1	S_1	S_1	S_1

S represents a set of subjects

1. There are two Factors (A,B) with p and q levels of treatments respectively. The experiment consists of pq treatment combinations. The above example includes three levels of Factor A, two levels of Factor B.

2. Subjects are randomly assigned to the pq treatment combinations with each subject or a set of matched subjects receiving all combinations. The order of administration of the pq combinations is randomized independently for each subject. If sets of matched subjects are used, one subject from each set is randomly assigned to each treatment combination.

3. There should be more than one subject per pq treatment combinations.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, Factor B varies most rapidly; then Factor A, then subjects. (For example, record one contains subject one, treatments ab_{11}, ab_{12} . . ., ab_{1q}; record two, subject one, treatment ab_{21}, ab_{22} . . ., ab_{2q} . . ., subject one, treatment ab_{p1}, ab_{p2} . . ., ab_{pq}; next record, subject two, treatments ab_{11}, ab_{12}. . ., ab_{iq} . . ., subject n, treatments ab_{p1}, ab_{p2} . . ., ab_{pq}.) A printout of the raw data file would show q data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of Factor A (maximum 25)

   b. number of levels of Factor B (maximum 25)

   c. number of subjects (maximum 1000)

   d. name of data file

   e. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the nubmer of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 238-240.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

```
 RU,AV22
AV22 OR RBF-P,Q   TWO WAY ANOVA WITH REPEATED MEASURES
          OR BLOCKS ON BOTH FACTORS.  INDEX FOR FACTOR B FIRST,
           THEN A AND LAST SUBJECTS.  PROGRAM EXPECTS Q POINTS PER LINE
ENTER DATA FILE NAME
#JRBPQ


 ENTER FORMAT OF DATA
(4(2X,F8.4))
 ENTER 1 FOR CRT, 6 FOR LINE PRINTER OUTPUT
6
 LEVELS OF A
2
 LEVELS OF B
4
 HOW MANY SUBJECTS
4
PRINT OUT OF RAW DATA (1=YES,Ø=NO)
1
:
```

RAW DATA

3.0000	4.0000	7.0000	7.0000
1.0000	2.0000	5.0000	10.0000
6.0000	5.0000	8.0000	8.0000
2.0000	3.0000	6.0000	10.0000
3.0000	4.0000	7.0000	9.0000
2.0000	4.0000	5.0000	9.0000
3.0000	3.0000	6.0000	8.0000
2.0000	3.0000	6.0000	11.0000

CELL	N	SUMX	SUMX2	MEAN	SD
1 1	4	15.000	63.000	3.750	1.500
1 2	4	16.000	66.000	4.000	.816
1 3	4	28.000	198.000	7.000	.816
1 4	4	32.000	258.000	8.000	.816
2 1	4	7.000	13.000	1.750	.500
2 2	4	12.000	38.000	3.000	.816
2 3	4	22.000	122.000	5.500	.577
2 4	4	40.000	402.000	10.000	.816

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	3.125	1	3.125	4.953	.03516
B	194.500	3	64.833	102.755	.00000
AB	19.375	3	6.458	10.236	.00041
RESIDUAL	13.250	21.	.631		
TOTAL	235.500	31.			

```
*AV22  T=00003 IS ON CR00002 USING 00016 BLKS R=0000

FTN4,L
      PROGRAM AV22
      DOUBLE PRECISION ABB(400),SSS(1000),AII(20),BJJ(20),BSS(20),PF3
      DOUBLE PRECISION X1(400),X2(400),XR(20),WC1,A1B1,AB2,AF2,BG2
      DOUBLE PRECISION X,SY,SX,SA,AS,BS,AF,AB,BG,WC,XN,XB,SD,DW,DI
      DOUBLE PRECISION AF3,BG3,AB3,A1,B1,DP,AF1,BG1,AB1,ZEE,PF1,PF2
      DIMENSION NFILE(3),IFMT(20),IB(272),IBUF(256)
      INTEGER A,B
      WRITE(1,4400)
4400  FORMAT("AV22 OR RBF-P,Q   TWO WAY ANOVA WITH REPEATED MEASURES"
     $,/,10X,"OR BLOCKS ON BOTH FACTORS.  INDEX FOR FACTOR B FIRST,",
     %/,10X," THEN A AND LAST SUBJECTS.  PROGRAM EXPECTS Q POINTS "
     &,"PER LINE",/,
     C"ENTER DATA FILE NAME")
      READ(1,16)NFILE
16    FORMAT(3A2)
      IDCBS=256
      CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
      IF(IER.LT.0)GO TO 999
      WRITE(1,4401)
4401  FORMAT ( " ENTER FORMAT OF DATA " )
      READ(1,6)IFMT
6     FORMAT(20A2)
      WRITE(1,145)
145   FORMAT(" ENTER 1 FOR CRT, 6 FOR LINE PRINTER OUTPUT")
      READ(1,*) IUNIT
      WRITE(1,4402)
4402  FORMAT ( " LEVELS OF A ")
      READ(1,*)  A
      WRITE(1,4403)
4403  FORMAT ( " LEVELS OF B ")
      READ(1,*)  B
      WRITE(1,4404)
4404  FORMAT ( " HOW MANY SUBJECTS ")
      READ(1,*)  N
      WRITE(1,942)
942   FORMAT("PRINT OUT OF RAW DATA (1=YES,0=NO)?")
      READ(1,*) IPTO
      DO 250 K=1,N
      DO 320 I=1,A
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (XR(KL),KL=1,B)
      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (XR(J),J=1,B)
      DO 430 J=1,B
      X=XR(J)
      SY=SY+X*X
      II=(I-1)*B+J
      X1(II)=X1(II)+X
      X2(II)=X2(II)+X*X
      SX=SX+X
```

```
      II=I+A*(J-1)
      ABB(II)=ABB(II)+X
      SSS(K)=SSS(K)+X
      AII(I)=AII(I)+X
      BJJ(J)=BJJ(J)+X
      BSS(J)=BSS(J)+X
430   SA=SA+X
      AS=AS+SA*SA/B
320   SA=0
      DO 250 J=1,B
      BS=BS+BSS(J)*BSS(J)/A
250   BSS(J)=0
      DO 230 I=1,A
      AF=AF+AII(I)*AII(I)/(B*N)
      DO 630 J=1,B
      II=I+A*(J-1)
      AB=AB+ABB(II)*ABB(II)/N
630   CONTINUE
230   CONTINUE
      DO 240 J=1,B
      BG=BG+BJJ(J)*BJJ(J)/(A*N)
240   CONTINUE
      X=0
      DO 1450 I=1,N
1450  X=X+SSS(I)*SSS(I)/(A*B)
      SX=SX*SX/(A*B*N)
      WC=SY+SX-X-AB
      SY=SY-SX
      AB=AB+SX-AF-BG
      AF=AF-SX
      BG=BG-SX
      WRITE(IUNIT,101)
101   FORMAT(////,"0 CELL",6X,"N",10X,"SUMX",6X,"SUMX2",8X,
     1"MEAN",8X,"SD",/)
      XN=N
      DO 102 I=1,A
      DO 102 J=1,B
      II=(I-1)*B+J
      XB=X1(II)/XN
      SD=DSQRT((X2(II)-(X1(II)*X1(II))/XN)/(XN-1.))
102   WRITE(IUNIT,127) I,J,N,X1(II),X2(II),XB,SD
127   FORMAT(2I3,3X,I4,3X,4(1X,F10.3))
      WRITE(IUNIT,810)
810   FORMAT(///,15X,"SOURCE TABLE",//," SOURCE",9X,"SS",8X,"DF",
     110X,"MS",10X,"F",11X,"P(F)",/)
      DW=(A*B-1)*(N-1)
      A=A-1
      B=B-1
      DI=A*B
      WC1=WC
      A1B1=(A+1)*(B+1)*N-1
      WC=WC/DW
```

```
      AB2=AB/DI
      AF2=AF/A
      BG2=BG/B
      AF3=AF2/WC
      BG3=BG2/WC
      AB3=AB2/WC
      A1=A
      B1=B
      DP=DW
      AF1=AF3
      BG1=BG3
      AB1=AB3
      CALL FPROB(AF1,A1,DP,ZEE,PF1)
      DP=DW
      CALL FPROB(BG1,B1,DP,ZEE,PF2)
      DP=DW
      CALL FPROB(AB1,DI,DP,ZEE,PF3)
      WRITE(IUNIT,820) AF,A,AF2,AF3,PF1,BG,B,BG2,BG3,PF2,AB,DI,AB2,
     1AB3,PF3,WC1,DW,WC,SY,A1B1
820   FORMAT(3X,"A",9X,F8.3,5X,I3,2(5X,F8.3),,5X,F8.5,/,
     13X,"B",9X,F8.3,5X,I3,2(5X,F8.3),5X,F8.5,/,
     22X,"AB",9X,F8.3,5X,I3,2(5X,F8.3),5X,F8.5,/,
     32X,"RESIDUAL",X,F10.3,X,F8.0,4X,F8.3,//," TOTAL",7X,F8.3,1X,
     4F8.0)
      CALL CLOSE(IB,IER)
      GO TO 987
999   WRITE(1,4409)
4409  FORMAT (  " ERROR ON CALL OPEN STATEMENT "  )
      STOP
987   END
      END$
```

AV30 (CRF - P,Q,R) (Three-way ANOVA)

Purpose:

This program performs a three-way completely randomized factorial analysis of variance without replication.

Mathematical Model:

The model for this design is:

$$X_{ijkm} = u + A_i + B_j = C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + E_{m(ijk)}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $C_k = 0$ for all k

Ho: $AB_{ij} = 0$ for all ij

Ho: $AC_{ik} = 0$ for all ik

Ho: $BC_{jk} = 0$ for all jk

Ho: $ABC_{ijk} = 0$ for all ijk

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

	B_1		B_2	
	C_1	C_2	C_1	C_2
A_1	S_1	S_2	S_3	S_4
A_2	S_5	S_6	S_7	S_8

S represents a set of subjects

1. There are three Factors (A,B,C) with p, q, and r levels of treatments respectively. The experiment consists of pqr treatment combinations. The above example includes two levels of each of Factors A, B, and C.

2. Subjects are randomly assigned to the pqr treatment combinations with each subject receiving only one combination.

3. There should be more than one subject per pqr treatment combination.

User Considerations and Procedures:

1. A data file must be created with each point in a sequential file indexing for subjects within Factor C fastest, then Factor B, and finally A. (For example, first record is subject one for treatment abc_{111}, second record is subject two for treatment abc_{111}. . ., then subject one for treatment abc_{112}, then subject two for treatment abc_{112} . . ., last record would be subject n for treatment abc_{pqr}.) A printout of the raw data file would show one data point per line.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by above option (#2).

4. Parameters required:

   a. number of levels of Factor A (maximum 9)

   b. number of levels of Factor B (maximum 9)

   c. number of levels of Factor C (maximum 9)

   d. number of subjects per ABC cell (maximum 32767)

   e. name of data file

   f. format of data file

5. Printout gives:

   a. raw data (optional)

   b. for each cell (treatment combination): N, Σx, Σx^2, $\bar{X}$, and SD (unbiased estimate)

   c. ANOVA course table

Comments:

Program uses least square analysis for unequal cell sample sizes. This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 218-221.

The accuracy of this program is less than that obtained by the Statistical Analysis System and Statistical Package for Social Sciences. The data analysis output is only accurate to five digit places instead of ten digits.

```
RU,AV3Ø
AV3Ø OR CRFPQR
REF: BRUNING & KINTZ, 1968
SECTION 2.3
FACTORIAL DESIGN:  THREE FACTORS
      NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR
             FACTOR C WILL VARY MOST RAPIDLY, INDEX
             FOR FACTOR B VARIES NEXT, THEN INDEX
             FOR FACTOR A VARIES.  PROGRAM EXPECTS
             ALL DATA TO BE IN ONE SEQUENTIAL FILE.
      NOTE:  MAX 9 * 9 * 9 DESIGN
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , Ø = NO
1
ENTER NAME OF INPUT DATA FILE:
#AV2Ø


ENTER INPUT DATA FORMAT:
(4x,F1Ø.4)
ENTER # LEVELS FACTORS A, B, & C:
2,2,2
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          1
FACTOR C, LEVEL:          1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          1
FACTOR C, LEVEL:          2
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          2
FACTOR C, LEVEL:          1
ENTER ## SS THIS CELL:
4
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          2
FACTOR C, LEVEL:          2
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          1
FACTOR C, LEVEL:          1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          1
FACTOR C, LEVEL:          2
ENTER # SS THIS CELL:
4
```

```
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          2
FACTOR C, LEVEL:          1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          2
FACTOR C, LEVEL:          2
ENTER # SS THIS CELL:
4
:
```

```
LEVEL:      1  1  1   RAW DATA
         3.0000
         6.0000
         3.0000
         3.0000
LEVEL:      1  1  2   RAW DATA
         4.0000
         5.0000
         4.0000
         3.0000
LEVEL:      1  2  1   RAW DATA
         7.0000
         8.0000
         7.0000
         6.0000
LEVEL:      1  2  2   RAW DATA
         7.0000
         8.0000
         9.0000
         8.0000
LEVEL:      2  1  1   RAW DATA
         1.0000
         2.0000
         2.0000
         2.0000
LEVEL:      2  1  2   RAW DATA
         2.0000
         3.0000
         4.0000
         3.0000
LEVEL:      2  2  1   RAW DATA
         5.0000
         6.0000
         5.0000
         6.0000
LEVEL:      2  2  2   RAW DATA
        10.0000
         9.0000
        11.0000
        10.0000
```

CELL	N	SUMX	SUMX2	MEAN	SD
1 1 1	4	15.000	63.000	3.750	1.500
1 1 2	4	16.000	66.000	4.000	.816
1 2 1	4	28.000	198.000	7.000	.816
1 2 2	4	32.000	258.000	8.000	.816
2 1 1	4	7.000	13.000	1.750	.500
2 1 2	4	12.000	38.000	3.000	.816
2 2 1	4	22.000	122.000	5.500	.577
2 2 2	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
FACTOR A	3.125	1.	3.125	4.054	.052693
FACTOR B	162.000	1.	162.000	210.162	.000000
FACTOR C	24.500	1.	24.500	31.784	.000050
A * B	6.125	1.	6.125	7.946	.009279
A * C	10.125	1.	10.125	13.135	.001666
B * C	8.000	1.	8.000	10.378	.003874
A * B * C	3.125	1.	3.125	4.054	.052693
ERROR	18.500	24.	.771		

```
*AV30  T=00004 IS ON CR00002 USING 00027 BLKS R=0224

FTN4,L
      PROGRAM AV30
      DOUBLE PRECISION MSA,MSB,MSC,MSAB,MSAC,MSBC,MSABC,MSER
      DOUBLE PRECISION FA,FB,FC,FAB,FAC,FBC,FABC,F,DF1,DF2,Z
      DOUBLE PRECISION PA,PB,PC,PAB,PAC,PBC,PABC
      DOUBLE PRECISION SX2(8,8,8),XBAR(8,8,8),SD(8,8,8)
      DOUBLE PRECISION S2(8,8,8),S6(8),S7(8),S8(8),S9(8,8),S10(8,8),
     $S11(8,8),RDATA,TSS,S3,S4,CT,SST,SSA,SSB,SSC,SSAB,SSAC,SSBC,
     $SSABC,SSER,DFT,DFA,DFB,DFC,DFAB,DFAC,DFBC,DFABC,DFER
      DIMENSION IB(144),IBUF(128),IFMT(20),INFILE(3),NS(8,8,8)
      DIMENSION NS6(8),NS7(8),NS8(8),NS9(8,8),NS10(8,8),NS11(8,8)
      WRITE(1,4400)
4400  FORMAT ( "AV30 OR CRFPQR" ,/,
     C "REF: BRUNING & KINTZ, 1968" ,/,
     C "SECTION 2.3"  ,/,
     C "FACTORIAL DESIGN:  THREE FACTORS" ,/,
     C "     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR" ,/,
     C "            FACTOR C WILL VARY MOST RAPIDLY, INDEX" )
      WRITE(1,4406)
4406  FORMAT ( "            FOR FACTOR B VARIES NEXT, THEN INDEX" ,/,
     C "            FOR FACTOR A VARIES.  PROGRAM EXPECTS"  ,/,
     C "            ALL DATA TO BE IN ONE SEQUENTIAL FILE." ,/,
     C "     NOTE:  MAX 8 * 8 * 8 DESIGN" )
4975  WRITE(1,4410)
4410  FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
      READ(1,*) IUNIT
      IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 4975
      WRITE(1,4411)
4411  FORMAT ("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO ")
      READ(1,*)  IPTO
      WRITE(1,4412)
4412  FORMAT ( "ENTER NAME OF INPUT DATA FILE:" )
      READ(1,498)INFILE
498   FORMAT(3A2)
      IDCBS=128
      CALL OPEN (IB,IER,INFILE,3,0,-2,IDCBS)
      IF(IER.GE.0)GO TO 4985
      WRITE(1,4413) INFILE,IER
4413  FORMAT(5X,3A2,4X,"NO OPEN INPUT DATA FILE, IER = ",I5  )
      STOP 4413
4985  WRITE(1,4414)
4414  FORMAT ( "ENTER INPUT DATA FORMAT:" )
      READ(1,477)IFMT
477   FORMAT(20A2)
      WRITE(1,4415)
4415  FORMAT ( "&ENTER # LEVELS FACTORS A, B, & C: ")
      READ(1,*)  NLA,NLB,NLC
      DO 500 LA=1,NLA
      DO 500 LB=1,NLB
      DO 500 LC=1,NLC
      WRITE(1,4416) LA
```

```
 4416  FORMAT ( "FACTOR A, LEVEL: ",I5 )
       WRITE(1,4417) LB
 4417  FORMAT ( "FACTOR B, LEVEL: ",I5 )
       WRITE(1,4418) LC
 4418  FORMAT ( "FACTOR C, LEVEL: ",I5 )
       WRITE(1,4419)
 4419  FORMAT ( "&ENTER # SS THIS CELL: ")
       READ(1,*)  NS(LA,LB,LC)
       K=NS(LA,LB,LC)
       IF(IPTO.EQ.1)WRITE(IUNIT,1)LA,LB,LC
 1     FORMAT(" LEVEL:  ",3I3,"  RAW DATA")
       DO 499 N=1,K
       CALL READF(IB,IER,IBUF)
       CALL CODE
       READ(IBUF,IFMT)RDATA
       IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)RDATA
       TSS=TSS+1
       S2(LA,LB,LC)=S2(LA,LB,LC)+RDATA
       SX2(LA,LB,LC)=SX2(LA,LB,LC)+RDATA**2
       S3=S3+RDATA**2
       S4=S4+RDATA
       S6(LA)=S6(LA)+RDATA
       NS6(LA)=NS6(LA)+1
       S7(LB)=S7(LB)+RDATA
       NS7(LB)=NS7(LB)+1
       S8(LC)=S8(LC)+RDATA
       NS8(LC)=NS8(LC)+1
       S9(LA,LB)=S9(LA,LB)+RDATA
       NS9(LA,LB)=NS9(LA,LB)+1
       S10(LA,LC)=S10(LA,LC)+RDATA
       NS10(LA,LC)=NS10(LA,LC)+1
       S11(LB,LC)=S11(LB,LC)+RDATA
       NS11(LB,LC)=NS11(LB,LC)+1
 499   CONTINUE
 500   CONTINUE
       DO 501 I1=1,NLA
       DO 501 I2=1,NLB
       DO 501 I3=1,NLC
       ANS=NS(I1,I2,I3)
       XBAR(I1,I2,I3)=S2(I1,I2,I3)/ANS
       SD(I1,I2,I3)=DSQRT((ANS*SX2(I1,I2,I3)-
      $S2(I1,I2,I3)**2)/(ANS*(ANS-1.)))
 501   CONTINUE
       WRITE(IUNIT,502)(((I1,I2,I3,NS(I1,I2,I3),S2(I1,I2,I3),
      $SX2(I1,I2,I3),XBAR(I1,I2,I3),SD(I1,I2,I3),I3=1,NLC),I2=1,NLB),
      $I1=1,NLA)
 502   FORMAT("O CELL        N          SUMX         SUMX2        MEAN",
      $9X,"SD",/,(3I2,3X,I4,3X,4(1X,F10.3)))
       CT=S4**2/TSS
       SST=S3-CT
       DO 601 LA=1,NLA
 601   SSA=SSA+S6(LA)**2/NS6(LA)
       SSA=SSA-CT
       DO 701 LB=1,NLB
```

```
701   SSB=SSB+S7(LB)**2/NS7(LB)
      SSB=SSB-CT
      DO 801 LC=1,NLC
801   SSC=SSC+S8(LC)**2/NS8(LC)
      SSC=SSC-CT
      DO 901 LA=1,NLA
      DO 901 LB=1,NLB
901   SSAB=SSAB+S9(LA,LB)**2/NS9(LA,LB)
      SSAB=SSAB-SSA-SSB-CT
      DO 1001 LA=1,NLA
      DO 1001 LC=1,NLC
1001  SSAC=SSAC+S10(LA,LC)**2/NS10(LA,LC)
      SSAC=SSAC-SSA-SSC-CT
      DO 1101 LB=1,NLB
      DO 1101 LC=1,NLC
1101  SSBC=SSBC+S11(LB,LC)**2/NS11(LB,LC)
      SSBC=SSBC-SSB-SSC-CT
      DO 1201 LA=1,NLA
      DO 1201 LB=1,NLB
      DO 1201 LC=1,NLC
1201  SSABC=SSABC+S2(LA,LB,LC)**2/NS(LA,LB,LC)
      SSABC=SSABC-SSA-SSB-SSC-SSAB-SSAC-SSBC-CT
      SSER=SST-SSA-SSB-SSC-SSAB-SSAC-SSBC-SSABC
      DFT=TSS-1
      DFA=NLA-1
      DFB=NLB-1
      DFC=NLC-1
      DFAB=DFA*DFB
      DFAC=DFA*DFC
      DFBC=DFB*DFC
      DFABC=DFA*DFB*DFC
      DFER=DFT-DFA-DFB-DFC-DFAB-DFAC-DFBC-DFABC
      MSA=SSA/DFA
      MSB=SSB/DFB
      MSC=SSC/DFC
      MSAB=SSAB/DFAB
      MSAC=SSAC/DFAC
      MSBC=SSBC/DFBC
      MSABC=SSABC/DFABC
      MSER=SSER/DFER
      FA=MSA/MSER
      FB=MSB/MSER
      FC=MSC/MSER
      FAB=MSAB/MSER
      FAC=MSAC/MSER
      FBC=MSBC/MSER
      FABC=MSABC/MSER
      F=FA
      DF1=DFA
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PA)
      F=FB
      DF1=DFB
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PB)
```

```
      F=FC
      DF1=DFC
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PC)
      F=FAB
      DF1=DFAB
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PAB)
      F=FAC
      DF1=DFAC
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PAC)
      F=FBC
      DF1=DFBC
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PBC)
      F=FABC
      DF1=DFABC
      DF2=DFER
      CALL FPROB(F,DF1,DF2,Z,PABC)
      WRITE(IUNIT,1701)SST,DFT,SSA,DFA,MSA,FA,PA,SSB,DFB,MSB,FB,PB,
     $SSC,DFC,MSC,FC,PC,SSAB,DFAB,MSAB,FAB,PAB,SSAC,DFAC,MSAC,FAC,
     $PAC,SSBC,DFBC,
     $MSBC,FBC,PBC,SSABC,DFABC,MSABC,FABC,PABC,SSER,DFER,MSER
 1701 FORMAT(/,3X,"SOURCE",9X,"SS",5X,"DF",6X,"MS",10X,"F",7X,"P"//
     $"   TOTAL",5X,F10.3,F5.0/3X,"FACTOR A",2X,F10.3,F5.0,2F10.3,
     $F10.6/3X,"FACTOR B",2X,F10.3,F5.0,2F10.3,F10.6/3X,"FACTOR C".
     $2X,F10.3,F5.0,2F10.3,F10.6/3X,"A * B",5X,F10.3,F5.0,2F10.3,
     $F10.6,/,
     $3X,"A * C",5X,F10.3,F5.0,2F10.3,F10.6/3X,"B * C",5X,F10.3,F5.0,
     $2F10.3,F10.6/3X,"A * B * C",1X,F10.3,F5.0,2F10.3,F10.6/3X,
     $"ERROR",5X,F10.3,F5.0,F10.3)
      CALL CLOSE(IB,IER)
      END
      END$
```

AV31C (SPF-PQ.R) (Three-way Split Plot ANOVA, One Repeated Measure)

Purpose:

This program performs a three-way split-plot mixed analysis of variance with repeated measures on one factor.

Mathematical Model:

The model for this design is:

$$X_{ijkm} = u + A_i + B_j + C_k + AC_{ik} + AB_{ij} + BC_{jk} + ABC_{ijk} + \pi_{m(ij)} +$$
$$BD_{km(ij)} + E_{o(ijkm)}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $C_k = 0$ for all k

Ho: $AB_{ij} = 0$ for all ij

Ho: $AC_{ik} = 0$ for all ik

Ho: $BC_{jk} = 0$ for all jk

Ho: $ABC_{ijk} = 0$ for all ijk

The mixed model (Model III) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

		C_1	C_2	C_3
A_1	B_1	S_1	S_1	S_1
	B_2	S_2	S_2	S_2
A_2	B_1	S_3	S_3	S_3
	B_2	S_4	S_4	S_4

S represents a set of subjects

1. There are three Factors (A,B, and C) with p,q,r levels of treatments respectively. Factor A and B are designated as between blocks or nonrepeated measures. Factor C is the within block or repeated measure. The above example includes two levels of Factor A, two levels of Factor B, and three levels of Factor C.

2. Subjects from a common population are randomly assigned to the AB treatments. After this, levels of treatment C are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, index for Factor C first, then B, then subjects, and finally A. (For example, record one contains subject one, cell abc_{111}, abc_{112} . . ., abc_{11r}; second record is subject one abc_{121}, abc_{122} . . ., abc_{12r}; records continue for subject one until abc_{1q1}, abc_{1q2} . . ., abc_{1qr} have been entered. The remaining subjects in Factor A_1 should be entered in the same manner. Repeat the same procedures for subjects in Factor A_p.) A printout of the raw data would show r data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. levels of Factor A (maximum 9)

   b. levels of Factor B (maximum 9)

   c. levels of Factor C (maximum 9)

   d. number of subjects per AB cell (maximum 32767)

   e. name of data file

   f. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

Program uses least squares analysis for unequal AB cell sizes. This ANOVA design permits interaction effects to be evaluated. In a split-plot design, estimates of the within block (Factor C, interactions AC, BC, and ABC) effects are more accurate than estimates of the between-block (Factor A, Factor B, and interaction AB) effects. If an experimenter's primary interest is in the within-block effects, a split-plot design is more powerful than a randomized factorial block design (AV33). However, if equal precision for all treatment effects is desired the average power of a randomized factorial block design is greater. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested from data in Roger E. Kirk, Experimental Design for the Behavior Sciences, Wadsworth Publishing Company, 1968, pp. 284-287.

The accuracy of this program is less than that obtained by the Statistical Analysis System and by the Statistical Package for the Social Sciences. The data analysis output is only accurate to six digit places instead of ten digits.

```
 RU,AV31C
AV31C OR SPF- PQ.R
THREE FACTOR MIXED DESIGN:  REPEATED MEASURES ON ONE FACTOR
     NOTE:  PROGRAM CALCULATORS LEAST SQUARES
            SOLUTION IF UNEQUAL CELL N'S
     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR REPEATED
            MEASURES FACTOR (C) VARIES MOST RAPIDLY, INDEX FOR
            FACTOR B VARIES NEXT, THEN INDEX FOR FACTOR A VARIES.
            PROGRAM EXPECTS ALL DATA TO BE IN ONE MATRIX FILE.
     NOTE:  MAX 9 * 9 * 9 DESIGN.
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , Ø = NO
1
ENTER INPUT DATA FILE NAME:
#AV32
ENTER INPUT DATA FORMAT:
(4(4X,F1Ø.4)`


ENTER # LEVELS FACTOR A:
2
ENTER # LEVELS FACTOR B:
2
ENTER # LEVELS FACTOR C (RPT MS FACTOR):
4
FACTOR A, LEVEL:        1
FACTOR B, LEVEL:        1
ENTER # SS THIS CELL:
2
FACTOR A, LEVEL:        1
FACTOR B, LEVEL:        2
ENTER # SS THIS CELL:
2
FACTOR A, LEVEL:        2
FACTOR B, LEVEL:        1
ENTER # SS THIS CELL:
2
FACTOR A, LEVEL:        2
FACTOR B, LEVEL:        2
ENTER # SS THIS CELL:
2
:
```

LEVEL: 1 1	RAW DATA		
3.0000	4.0000	7.0000	7.0000
6.0000	5.0000	8.0000	8.0000
LEVEL: 1 2	RAW DATA		
3.0000	4.0000	7.0000	9.0000
3.0000	3.0000	6.0000	8.0000
LEVEL: 2 1	RAW DATA		
1.0000	2.0000	5.0000	10.0000
2.0000	3.0000	6.0000	10.0000
LEVEL: 2 2	RAW DATA		
2.0000	4.0000	5.0000	9.0000
2.0000	3.0000	6.0000	11.0000

CELL	N	SUMX	SUMX2	MEAN/	SD
1 1 1	2	9.000	45.000	4.500	2.121
1 1 2	2	9.000	41.000	4.500	.707
1 1 3	2	15.000	113.000	7.500	.707
1 1 4	2	15.000	113.000	7.500	.707
1 2 1	2	6.000	18.000	3.000	.000
1 2 2	2	7.000	25.000	3.500	.707
1 2 3	2	13.000	85.000	6.500	.707
1 2 4	2	17.000	145.000	8.500	.707
2 1 1	2	3.000	5.000	1.500	.707
2 1 2	2	5.000	13.000	2.500	.707
2 1 3	2	11.000	61.000	5.500	.707
2 1 4	2	20.000	200.000	10.000	.000
2 2 1	2	4.000	8.000	2.000	.000
2 2 2	2	7.000	25.000	3.500	.707
2 2 3	2	11.000	61.000	5.500	.707
2 2 4	2	20.000	202.000	10.000	1.414

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
BETWEEN SUBJECTS	12.500	7.			
FACTOR A	3.125	1.	3.125	1.724	.259214
FACTOR B	.125	1.	.125	.069	.799328
A * B	2.000	1.	2.000	1.103	.354230
ERROR B	7.250	4.	1.812		
WITHIN SUBJECTS	223.000	24.			
FACTOR C	194.500	3.	64.833	163.789	.000001
A * C	19.375	3.	6.458	16.316	.000318
B * C	1.375	3.	.458	1.158	.366568
A * B * C	3.000	3.	1.000	2.526	.106246
ERROR W	4.750	12.	.396		

```
"AV31C T=00004 IS ON CR00002 USING 00030 BLKS R=0238

FTN4,L
      PROGRAM AV31C
      DOUBLE PRECISION SX2(8,8,8),SD(8,8,8),XBAR(8,8,8),TSS,S4,S5,
     $GT,S9,CT,SST,SSB,SSFA,SSFB,SSAB,ERB,SSW,SSFC,SSAC,SSBC,SSABC,
     $ERW,DFT,DFB,DFFA,DFFB,DFAB,DFERB,DFW,DFFC,DFAC,DFBC,DFABC,
     $DFERW,FA,FB,FAB,FC,FAC,FBC,FABC,F,DF1,DF2,Z,PA,PB,PAB,PC,
     $PAC,PAC,PABC
      DOUBLE PRECISION DVEC(8),S2(8),S3(8,8),S10(8),S11(8),S15(8),
     $S16(8,8),S17(8,8),S18(8,8,8)
      DOUBLE PRECISION MSA,MSB,MSAB,MSERB,MSW,MSC,MSAC,MSBC,MSABC,
     CMSERW
      DIMENSION NSS(8,8),NS16(8),NS17(8),IFMT(20),IB(272),IBUF(256)
      DIMENSION INFILE(3)
      WRITE(1,4400)
4400  FORMAT("AV31C OR SPF- PQ.R",/,
     C"THREE FACTOR MIXED DESIGN: REPEATED MEASURES ON ONE FACTOR",/,
     C"     NOTE:  PROGRAM CALCULATES LEAST SQUARES" ,/,
     C"            SOLUTION IF UNEQUAL CELL N'S" ,/,
     C"     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR REPEATED")
      WRITE(1,4405)
4405  FORMAT("           MEASURES FACTOR (C) VARIES MOST RAPIDLY, ",
     $"INDEX FOR",/,
     C"            FACTOR B VARIES NEXT, THEN INDEX FOR FACTOR "
     $,"A VARIES.",/,
     C"            PROGRAM EXPECTS DATA TO BE IN ONE MATRIX FILE.",/,
     C"     NOTE:  MAX 8 * 8 * 8 DESIGN."  )
8975  WRITE(1,4409)
4409  FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
      READ(1,*) IUNIT
      IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 8975
      WRITE(1,4410)
4410  FORMAT("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO  ")
      READ(1,*) IPTO
      WRITE(1,4411)
4411  FORMAT ( "&ENTER INPUT DATA FILE NAME:" )
      READ(1,898)INFILE
898   FORMAT(3A2)
      WRITE(1,4412)
4412  FORMAT ( "&ENTER INPUT DATA FORMAT:"  )
      READ(1,876)IFMT
876   FORMAT(20A2)
      IDCBS=256
      CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
      IF(IER.GE.0) GO TO 908
      WRITE(1,564) INFILE,IER
564   FORMAT(5X,3A2," FAILED TO OPEN , IER = ",I5)
      STOP 564
908   WRITE(1,4413)
4413  FORMAT ( "ENTER # LEVELS FACTOR A: ")
      READ(1,*)  NLBA
      WRITE(1,4414)
```

```
4414  FORMAT ( "ENTER # LEVELS FACTOR B: ")
      READ(1,*)  NLBB
      WRITE(1,4415)
4415  FORMAT ( "ENTER # LEVELS FACTOR C (RPT MS FACTOR): ")
      READ(1,*)  NLW
      DO 900 LA=1,NLBA
      DO 900 LB=1,NLBB
      WRITE(1,4416) LA
4416  FORMAT ( "&FACTOR A, LEVEL: ",I5  )
      WRITE(1,4417) LB
4417  FORMAT ( "&FACTOR B, LEVEL: ",I5  )
      WRITE(1,4418)
4418  FORMAT ( "&ENTER # SS THIS CELL: ")
      READ(1,*)  NSS(LA,LB)
      NS=NSS(LA,LB)
      TSS=TSS+NS
      NS16(LA)=NS16(LA)+NSS(LA,LB)
      NS17(LB)=NS17(LB)+NSS(LA,LB)
      IF(IPTO.EQ.1)WRITE(IUNIT,1)LA,LB
1     FORMAT("  LEVEL:  ",2I4,"     RAW DATA")
      DO 900 N=1,NS
      S4=0
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(DVEC(IXW),IXW=1,NLW)
      IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)(DVEC(IXW),IXW=1,NLW)
      DO 899 LW=1,NLW
      S2(LW)=S2(LW)+DVEC(LW)
      S3(LA,LB)=S3(LA,LB)+DVEC(LW)
      S4=S4+DVEC(LW)
      S5=S5+DVEC(LW)**2
      S10(LA)=S10(LA)+DVEC(LW)
      S11(LB)=S11(LB)+DVEC(LW)
      S15(LW)=S15(LW)+DVEC(LW)
      S16(LA,LW)=S16(LA,LW)+DVEC(LW)
      S17(LB,LW)=S17(LB,LW)+DVEC(LW)
      S18(LA,LB,LW)=S18(LA,LB,LW)+DVEC(LW)
      SX2(LA,LB,LW)=SX2(LA,LB,LW)+DVEC(LW)**2
899   CONTINUE
      GT=GT+S4
      S9=S9+S4**2/NLW
900   CONTINUE
      DO 8994 IX1=1,NLBA
      DO 8994 IX2=1,NLBB
      DO 8994 IX3=1,NLW
      ANS=NSS(IX1,IX2)
      XBAR(IX1,IX2,IX3)=S18(IX1,IX2,IX3)/ANS
      SD(IX1,IX2,IX3)=DSQRT((ANS*SX2(IX1,IX2,IX3)-
     $S18(IX1,IX2,IX3)**2)/(ANS*(ANS-1.)))
8994  CONTINUE
      WRITE(IUNIT,8995)(((IX1,IX2,IX3,NSS(IX1,IX2),S18(IX1,IX2,IX3),
     $SX2(IX1,IX2,IX3),XBAR(IX1,IX2,IX3),SD(IX1,IX2,IX3),IX3=1,NLW),
     $IX2=1,NLBB),IX1=1,NLBA)
```

```
8995  FORMAT('0 CELL       N           SUMX      SUMX2           MEAN',
     $'            SD'/,(3I2,3X,I4,3X,4(1X,F10.3)))
      CT=GT**2/(TSS*NLW)
      SST=S5-CT
      SSB=S9-CT
      DO 1000 LA=1,NLBA
1000  SSFA=SSFA+S10(LA)**2/(NS16(LA)*NLW)
      SSFA=SSFA-CT
      DO 1100 LB=1,NLBB
1100  SSFB=SSFB+S11(LB)**2/(NS17(LB)*NLW)
      SSFB=SSFB-CT
      DO 1299 LA=1,NLBA
      DO 1299 LB=1,NLBB
1299  SSAB=SSAB+S3(LA,LB)**2/(NSS(LA,LB)*NLW)
      SSAB=SSAB-SSFA-SSFB-CT
1300  ERB=SSB-SSFA-SSFB-SSAB
1400  SSW=SST-SSB
      DO 1599 LW=1,NLW
1599  SSFC=SSFC+S15(LW)**2/TSS
      SSFC=SSFC-CT
      SSAC=0
      DO 1699 LA=1,NLBA
      DO 1699 LW=1,NLW
1699  SSAC=SSAC+S16(LA,LW)**2/NS16(LA)
      SSAC=SSAC-SSFA-SSFC-CT
      DO 1799 LB=1,NLBB
      DO 1799 LW=1,NLW
1799  SSBC=SSBC+S17(LB,LW)**2/NS17(LB)
      SSBC=SSBC-SSFB-SSFC-CT
      DO 1899 LA=1,NLBA
      DO 1899 LB=1,NLBB
      DO 1899 LW=1,NLW
1899  SSABC=SSABC+S18(LA,LB,LW)**2/NSS(LA,LB)
      SSABC=SSABC-SSFA-SSFB-SSAB-SSFC-SSAC-SSBC-CT
      ERW=SSW-SSFC-SSAC-SSBC-SSABC
      DFT=TSS*NLW-1
      DFB=TSS-1
      DFFA=NLBA-1
      DFFB=NLBB-1
      DFAB=DFFA*DFFB
      DFERB=DFB-DFFA-DFFB-DFAB
      DFW=DFT-DFB
      DFFC=NLW-1
      DFAC=DFFC*DFFA
      DFBC=DFFC*DFFB
      DFABC=DFFA*DFFB*DFFC
      DFERW=DFW-DFFC-DFAC-DFBC-DFABC
      MSA=SSFA/DFFA
      MSB=SSFB/DFFB
      MSAB=SSAB/DFAB
      MSERB=ERB/DFERB
      MSW=SSW/DFW
      MSC=SSFC/DFFC
      MSAC=SSAC/DFAC
      MSBC=SSBC/DFBC
      MSABC=SSABC/DFABC
      MSERW=ERW/DFERW
```

```
      FA=MSA/MSERB
      FB=MSB/MSERB
      FAB=MSAB/MSERB
      FC=MSC/MSERW
      FAC=MSAC/MSERW
      FBC=MSBC/MSERW
      FABC=MSABC/MSERW
      F=FA
      DF1=DFFA
      DF2=DFERB
      CALL FPROB(F,DF1,DF2,Z,PA)
      F=FB
      DF1=DFFB
      DF2=DFERB
      CALL FPROB(F,DF1,DF2,Z,PB)
      F=FAB
      DF1=DFAB
      DF2=DFERB
      CALL FPROB(F,DF1,DF2,Z,PAB)
      F=FC
      DF1=DFFC
      DF2=DFERW
      CALL FPROB(F,DF1,DF2,Z,PC)
      F=FAC
      DF1=DFAC
      DF2=DFERW
      CALL FPROB(F,DF1,DF2,Z,PAC)
      F=FBC
      DF1=DFBC
      DF2=DFERW
      CALL FPROB(F,DF1,DF2,Z,PBC)
      F=FABC
      DF1=DFABC
      DF2=DFERW
      CALL FPROB(F,DF1,DF2,Z,PABC)
      WRITE(IUNIT,2201)SST,DFT,SSB,DFB,SSFA,DFFA,MSA,FA,PA,SSFB,DFFB,
     $MSB,FB,PB,SSAB,DFAB,MSAB,FAB,PAB,ERB,DFERB,MSERB,SSW,DFW,SSFC,
     $DFFC,MSC,FC,PC,SSAC,DFAC,MSAC,FAC,PAC,SSBC,DFBC,MSBC,FBC,PBC,
     $SSABC,DFABC,MSABC,FABC,PABC,ERW,DFERW,MSERW
 2201 FORMAT("0",8X,"SOURCE",11X,"SS",5X,"DF",5X,"MS",9X,"F",11X,"P"
     $//" TOTAL",14X,F10.3,F5.0/"   BETWEEN SUBJECTS ",F10.3,F5.0/5X,
     $"FACTOR A",7X,F10.3,F5.0,2F10.3,F12.6/5X,"FACTOR B",7X,F10.3,
     $F5.0,2F10.3,F12.6/5X,"A * B",10X,F10.3,F5.0,2F10.3,F12.6/7X,
     $"ERROR B",6X,F10.3,
     $F5.0,F10.3//"   WITHIN SUBJECTS",2X,F10.3,F5.0/5X,"FACTOR C",
     $7X,F10.3,F5.0,2F10.3,F12.6/5X,"A * C",10X,F10.3,F5.0,2F10.3,
     $F12.6/,5X,"B * C",10X,F10.3,F5.0,2F10.3,F12.6,/,5X,"A * B * C"
     $,6X,F10.3,F5.0,2F10.3,F12.6,/,7X,"ERROR W",6X,F10.3,F5.0,F10.3)
      CALL CLOSE (18,IER)
      END
      END$
```

AV32BC (SPF-P.QR) (Three-way Split Plot ANOVA, Two Repeated Measures)

Purpose:

This program performs a three-way mixed split plot analysis of variance with repeated measures on two factors.

Mathematical Model:

The model for this design is:

$$X_{ijkm} = u + A_i + B_j + C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + \pi_{m(i)} +$$
$$B\pi_{jm(i)} + C\pi_{cm(i)} + BC\pi_{jkm(i)} + E_{o(ijkm)}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i
Ho: $B_i = 0$ for all j
Ho: $C_k = 0$ for all k
Ho: $AB_{ijk} = 0$ for all ij
Ho: $AC_{ik} = 0$ for all ik
Ho: $BC_{jk} = 0$ for all jk
Ho: $ABC_{ijk} = 0$ for all ijk

The mixed model (Model III) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

	B_1		B_2	
	C_1	C_2	C_1	C_2
A_1	S_1	S_1	S_1	S_1
A_2	S_2	S_2	S_2	S_2

S represents a set of subjects

1. There are three Factors (A,B, and C) with p, q, r levels of treatment respectively. Factor A is designated as the between block or nonrepeated measure. Factors B and C are the within blocks or repeated measures. The above example includes two levels each of Factors A, B, and C.

2. Subjects from a common population are randomly assigned to the levels of Factor A. After this, levels of treatments B and C are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, Factor C indexes first, then B, then subjects and finally A. (For example, record one contains subject one, cell abc_{111}, abc_{112} . . ., abc_{11r}, abc_{121}, abc_{122} . . ., abc_{12r}. . ., abc_{1q1}, abc_{1q2}. . ., abc_{1qr}; the next record contains the same information for subject two. The remaining subjects in Factor A_1 should be entered in the same manner. Repeat the same procedure for subjects in A_p.) A printout of the raw data would show qr data points.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. levels of Factor A (maximum 11)

   b. levels of Factor B (maximum 11)

   c. levels of Factor C (or groups) (maximum 11)

   d. number of subjects per group (maximum 32767)

   e. data file name

   f. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

Program uses least squares analysis for unequal cell sizes on Factor A. This ANOVA design permits interaction effects to be evaluated. In a split-plot design, estimates of the within-block (Factor B, Factor C, interactions AB, AC, BC, and ABC) effects are more accurate than estimates of between-block (Factor A) effects. If an experimenter's primary interest is in the within-block effects, a split-plot design is more powerful than a randomized factorial block design (AV33). However, if equal precision for all treatment effects is desired, the average power of a randomized factorial block design is greater. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested from data in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 298-302.

The accuracy of this program is less than that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences. The data analysis output is only accurate to six digit places instead of ten digits.

```
 RU,AV32
AV32AB OR SPF P.QR
REF:  BRUNING & KINTZ, 1968
SECTION 2.9
THREE-FACTOR MIXED DESIGN:  REPEATED MEASURES ON TWO FACTORS
     NOTE:  PROGRAM CALCULATES LEAST SQUARES
            SOLUTION IF UNEQUAL CELL N's
     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR 2ND WITHIN
            FACTOR (C) VARIES MOST RAPIDLY, INDEX FOR 1ST WITHIN
            FACTOR (B) VARIES NEXT, THEN INDEX FOR THE BETWEEN
            FACTOR (A) VARIES.  PROGRAM EXPECTS ALL DATA TO
            BE IN ONE MATRIX FILE.
     NOTE:  MAX 11 * 11 * 11 DESIGN.
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , Ø = NO
1
ENTER INPUT FILE NAME:
#AV32


ENTER INPUT DATA FORMAT:
(4(4X,F1Ø.4))
ENTER # OF LEVELS ON FACTORS B & C, AND # OF GROUPS:
2,2,2
ENTER GP # AND # SS IN GROUP:
1,4
ENTER GP # AND # SS IN GROUP:
2,4
  AV32   :  STOP   ØØØØ
:
```

GROUP: 1 RAW DATA

3.0000	4.0000	7.0000	7.0000
6.0000	5.0000	8.0000	8.0000
3.0000	4.0000	7.0000	9.0000
3.0000	3.0000	6.0000	8.0000

GROUP: 2 RAW DATA

1.0000	2.0000	5.0000	10.0000
2.0000	3.0000	6.0000	10.0000
2.0000	4.0000	5.0000	9.0000
2.0000	3.0000	6.0000	11.0000

CELL			N	SUMX	SUMX2	MEAN	SD
1	1	1	4	15.000	63.000	3.750	1.500
1	1	2	4	16.000	66.000	4.000	.816
1	2	1	4	28.000	198.000	7.000	.816
1	2	2	4	32.000	258.000	8.000	.816
2	1	1	4	7.000	13.000	1.750	.500
2	1	2	4	12.000	38.000	3.000	.816
2	2	1	4	22.000	122.000	5.500	.577
2	2	2	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
BETWEEN SUBJECTS	12.500	7.			
GROUPS (A)	3.125	1.	3.125	2 000	.205762
ERROR (A)	9.375	6.	1.562		
WITHIN SUBJECTS	223.000	24.			
FACTOR B	162.000	1.	162.000	199.385	.000095
FACTOR C	24.500	1.	24.500	61.895	.000521
A * B	6.125	1.	6.125	7.538	.032735
A * C	10.125	1.	10.125	25.579	.002835
B * C	8.000	1.	8.000	25.600	.002831
A * B * C	3.125	1.	3.125	10.000	.019275
ERROR (B)	4.875	6.	.813		
ERROR (C)	2.375	6.	.396		
ERROR (BC)	1.875	6.	.313		

```
*AV32B T=00004 IS ON CR00002 USING 00033 BLKS R=0266

FTN4,L
      PROGRAM AV32B
C THISPROGRAM NAME USED TO BE AV32BC BUT NAME WAS TO LONG
      DOUBLE PRECISION MSGPS,MSERB,MSA,MSB,MSAXC,MSBXC,MSAXB,MSABC,
     $MSER1,MSER2,MSER3,C,A,B,AC,BC,AB,ABC,F,DF1,DF2,PC,PA,PB,PAC,
     $PBC,PAB,PBC,PABC,TSS,SUM8,SUM4,SUM3,SUM18B,SUM8B,SUM19B,XBAR,
     $SD,CT,SST,SUM7B,SSGPS,SSB,SSERRB,SSW,SSFA,SSFB,SSAXC,SSBXC,
     $SSAXB,SSABC,SSEWS,SSER1,SSER2,SSER3,DFT,DFB,DFGPS,DFERB,DFW,
     $DFFA,DFFB,DFAXC,DFBXC,DFAXB,DFABC,DFERRW,DFER1,DFER2,DFER3
      DOUBLE PRECISION SX2(8,8,8),DMTRX(8,8),
     $SUM18(8),SUM19(8),SUM2(8,8,8),SUM11(8),SUM12(8),
     $SUM13(8,8),SUM14(8,8),SUM15(8,8),SUM7A(8)
      DIMENSION INFILE(3),IFMT(20),IB(272),IBUF(256),NSS(10)
      WRITE(1,4400)
4400  FORMAT ( "AV32BC OR SPF P.QR",/,
     C"REF:  BRUNING & KINTZ, 1968"  ,/,
     C"SECTION 2.9"  ,/,
     C"THREE-FACTOR MIXED DESIGN:REPEATED MEASURES ON TWO FACTORS",/,
     C"     NOTE:  PROGRAM CALCULATES LEAST SQUARES" ,/,
     C"            SOLUTION IF UNEQUAL CELL N'S" )
      WRITE(1,4406)
4406  FORMAT(" NOTE:ON INPUT DATA READ SEQUENCE, INDEX FOR 2ND "
     $,"WITHIN",/,
     C"       FACTOR (C) VARIES MOST RAPIDLY, INDEX FOR 1ST WITHIN",/,
     C"       FACTOR (B) VARIES NEXT, THEN INDEX FOR THE BETWEEN",/,
     C"       FACTOR (A) VARIES.  PROGRAM EXPECTS ALL DATA TO",/,
     C"       BE IN ONE MATRIX FILE."  ,/,
     C"     NOTE:  MAX 8 * 8 * 8 DESIGN"  )
      WRITE(1,4412)
4412  FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
      READ(1,*) IUNIT
      WRITE(1,4413)
4413  FORMAT("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO   ")
      READ(1,*) IPTO
      WRITE(1,4414)
4414  FORMAT ( "&ENTER INPUT FILENAME: "  )
      READ(1,1005)INFILE
1005  FORMAT(3A2)
      IDCBS=256
      WRITE(1,4415)
4415  FORMAT ( "&ENTER INPUT DATA FORMAT:"  )
      READ(1,1001)IFMT
1001  FORMAT(20A2)
      CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
      IF(IER.GE.0) GO TO 234
      WRITE(1,546) INFILE,IER
546   FORMAT(5X,3A2,5X," FAILED TO OPEN , IER = ",I5)
      STOP 546
```

```
234    WRITE(1,4416)
4416   FORMAT("&ENTER # OF LEVELS ON FACTORS B & C, AND # OF GROUPS:")
       READ(1,*) NLF1R,NLF2R,NGPS
       DO 60 I3=1,NGPS
       WRITE(1,4417)
4417   FORMAT ( "&ENTER GP # AND # SS IN GROUP: ")
       READ(1,*)  NG, NSS(NG)
       IF(IPTO.EQ.1) WRITE(IUNIT,2) NG
2      FORMAT("   GROUP:     ",I4,"       RAW DATA")
       K=NSS(NG)
       DO 60 N=1,K
       SUM8=0
       DO 57 I1=1,8
       SUM18(I1)=0
       SUM19(I1)=0
57     CONTINUE
       CALL READF(IB,IER,IBUF)
       CALL CODE
       READ(IBUF,IFMT)((DMTRX(I1,I2),I2=1,NLF2R),I1=1,NLF1R)
       IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)((DMTRX(I1,I2),I2=1,NLF2R),
      $I1=1,NLF1R)
       TSS=TSS+1.
       DO 59 I1=1,NLF1R
       DO 58 I2=1,NLF2R
       SUM8=SUM8+DMTRX(I1,I2)
       SUM18(I1)=SUM18(I1)+DMTRX(I1,I2)
       SUM19(I2)=SUM19(I2)+DMTRX(I1,I2)
       SUM2(I1,I2,NG)=SUM2(I1,I2,NG)+DMTRX(I1,I2)
       SUM4=SUM4+DMTRX(I1,I2)
       SUM3=SUM3+DMTRX(I1,I2)**2
       SX2(I1,I2,NG)=SX2(I1,I2,NG)+DMTRX(I1,I2)**2
58     CONTINUE
       SUM18B=SUM18B+SUM18(I1)**2/NLF2R
59     CONTINUE
       SUM8B=SUM8B+SUM8**2
       DO 11 I2=1,NLF2R
       SUM19B=SUM19B+SUM19(I2)**2/NLF1R
11     CONTINUE
60     CONTINUE
       WRITE(IUNIT,605)
605    FORMAT("0 CELL       N            SUMX          SUMX2          MEAN"
      $,"             SD")
       DO 61 I3=1,NGPS
       DO 61 I1=1,NLF1R
       DO 61 I2=1,NLF2R
       ANS=NSS(I3)
       XBAR=SUM2(I1,I2,I3)/ANS
       SD=DSQRT((ANS*SX2(I1,I2,I3)-(SUM2(I1,I2,I3)**2))/
      X(ANS*(ANS-1.)))
       WRITE(IUNIT,606)I3,I1,I2,NSS(I3),SUM2(I1,I2,I3),
      $SX2(I1,I2,I3),XBAR,SD
606    FORMAT(3I2,3X,I4,3X,4(1X,F10.3))
61     CONTINUE
       CT=SUM4**2/(TSS*NLF1R*NLF2R)
       SST=SUM3-CT
       DO 79 I1=1,NGPS
       DO 73 I2=1,NLF1R
       DO 73 I3=1,NLF2R
```

```
      SUM7A(I1)=SUM7A(I1)+SUM2(I2,I3,I1)
      SUM11(I2)=SUM11(I2)+SUM2(I2,I3,I1)
      SUM12(I3)=SUM12(I3)+SUM2(I2,I3,I1)
      SUM13(I2,I1)=SUM13(I2,I1)+SUM2(I2,I3,I1)
      SUM14(I3,I1)=SUM14(I3,I1)+SUM2(I2,I3,I1)
      SUM15(I2,I3)=SUM15(I2,I3)+SUM2(I2,I3,I1)
      SUM2(I2,I3,I1)=SUM2(I2,I3,I1)**2
78    CONTINUE
      SUM7B=SUM7B+(SUM7A(I1)**2/(NSS(I1)*(NLF1R*NLF2R)))
79    CONTINUE
      SSGPS=SUM7B-CT
      SSB=SUM8B/(NLF1R*NLF2R)-CT
      SSERRB=SSB-SSGPS
      SSW=SST-SSB
      DO 119 I1=1,NLF1R
119   SSFA=SSFA+SUM11(I1)**2/(TSS*NLF2R)
      SSFA=SSFA-CT
      DO 129 I1=1,NLF2R
129   SSFB=SSFB+SUM12(I1)**2/(TSS*NLF1R)
      SSFB=SSFB-CT
      DO 139 I1=1,NLF1R
      DO 139 I2=1,NGPS
139   SSAXC=SSAXC+SUM13(I1,I2)**2/(NSS(I2)*NLF2R)
      SSAXC=SSAXC-SSGPS-SSFA-CT
      DO 149 I1=1,NLF2R
      DO 149 I2=1,NGPS
149   SSBXC=SSBXC+SUM14(I1,I2)**2/(NSS(I2)*NLF1R)
      SSBXC=SSBXC-SSGPS-SSFB-CT
      DO 159 I1=1,NLF1R
      DO 159 I2=1,NLF2R
159   SSAXB=SSAXB+SUM15(I1,I2)**2/TSS
      SSAXB=SSAXB-SSFA-SSFB-CT
      DO 169 I1=1,NLF1R
      DO 169 I2=1,NLF2R
      DO 169 I3=1,NGPS
169   SSABC=SSABC+SUM2(I1,I2,I3)/NSS(I3)
      SSABC=SSABC-SSGPS-SSFA-SSFB-SSAXC-SSBXC-SSAXB-CT
      SSEWS=SSW-SSFA-SSFB-SSAXC-SSBXC-SSAXB-SSABC
      SSER1=SUM18B-SSB-SSFA-SSAXC-CT
      SSER2=SUM19B-SSB-SSFB-SSBXC-CT
      SSER3=SSEWS-SSER1-SSER2
      DFT=TSS*NLF1R*NLF2R-1.
      DFB=TSS-1.
      DFGPS=NGPS-1.
      DFERB=DFB-DFGPS
      DFW=DFT-DFB
      DFFA=NLF1R-1.
      DFFB=NLF2R-1.
      DFAXC=DFGPS*DFFA
      DFBXC=DFGPS*DFFB
      DFAXB=DFFA*DFFB
      DFABC=DFFA*DFFB*DFGPS
      DFERRW=DFW-DFFA-DFFB-DFAXC-DFBXC-DFAXB-DFABC
      DO 219 I1=1,NGPS
```

```
      DFER1=DFER1+DFFA*(NSS(I1)-1)
      DFER2=DFER2+DFFB*(NSS(I1)-1)
      DFER3=DFER3+DFFA*DFFB*(NSS(I1)-1)
219   CONTINUE
      MSGPS=SSGPS/DFGPS
      MSERB=SSERRB/DFERB
      MSA=SSFA/DFFA
      MSB=SSFB/DFFB
      MSAXC=SSAXC/DFAXC
      MSBXC=SSBXC/DFBXC
      MSAXB=SSAXB/DFAXB
      MSABC=SSABC/DFABC
      MSER1=SSER1/DFER1
      MSER2=SSER2/DFER2
      MSER3=SSER3/DFER3
      C=MSGPS/MSERB
      A=MSA/MSER1
      B=MSB/MSER2
      AC=MSAXC/MSER1
      BC=MSBXC/MSER2
      AB=MSAXB/MSER3
      ABC=MSABC/MSER3
      F=C
      DF1=DFGPS
      DF2=DFERB
      CALL FPROB(F,DF1,DF2,Z,PC)
      F=A
      DF1=DFFA
      DF2=DFER1
      CALL FPROB(F,DF1,DF2,Z,PA)
      F=B
      DF1=DFFB
      DF2=DFER2
      CALL FPROB(F,DF1,DF2,Z,PB)
      F=AC
      DF1=DFAXC
      DF2=DFER1
      CALL FPROB(F,DF1,DF2,Z,PAC)
      F=BC
      DF1=DFBXC
      DF2=DFER2
      CALL FPROB(F,DF1,DF2,Z,PBC)
      F=AB
      DF1=DFAXB
      DF2=DFER3
      CALL FPROB(F,DF1,DF2,Z,PAB)
      F=ABC
      DF1=DFABC
      DF2=DFER3
      CALL FPROB(F,DF1,DF2,Z,PABC)
      WRITE(IUNIT,1004)
1004  FORMAT('0***** SOURCE *****',5X,'SS',6X,'DF',9X,'MS',10X,'F',
     $7X,'P'/)
```

```
      WRITE(IUNIT,1003) SST,DFT,SSB,DFB,SSGPS,DFGPS,MSGPS,
     $C,PC,SSERRB,DFERB,MSERB,SSW,DFW,SSFA,DFFA,MSA,A,PA,
     $SSFB,DFFB,MSB,B,PB,SSAXC,DFAXC,MSAXC,AC,PAC,SSBXC,DFBXC,
     $MSBXC,BC,PBC,SSAXB,DFAXB,MSAXB,AB,PAB,SSABC,DFABC,MSABC,ABC,
     $PABC,SSER1,DFER1,MSER1,SSER2,DFER2,MSER2,SSER3,DFER3,MSER3
 1003 FORMAT("0TOTAL",14X,F10.3,F5.0/"   BETWEEN SUBJECTS",F11.3,
     $F5./5X,"GROUPS (A)",5X,F10.3,F5.,4X,2F10.3,F10.6/7X,"ERROR(A)"
     $,5X,F10.3,F5.,4X,F10.3,/"0  WITHIN SUBJECTS",2X,F10.3,F5.,/5X,
     $"FACTOR B",7X,F10.3,F5.,4X,2F10.3,F10.6,/5X,"FACTOR C",7X,
     $F10.3,
     $F5.,4X,2F10.3,F10.6,/5X,"A X B",10X,F10.3,F5.,4X,2F10.3,F10.6,
     $/5X,"A X C",10X,F10.3,F5.,4X,2F10.3,F10.6,/5X,"B X C",10X,
     $F10.3,
     $F5.,4X,2F10.3,F10.6,/5X,"A X B X C ",5X,F10.3,F5.,4X,2F10.3,
     $F10.6,/,7X,"ERROR (B)",4X,F10.3,F5.0,4X,F10.3,/7X,"ERROR (C)"
     $,4X
     $,F10.3,F5.,4X,F10.3,/,7X,"ERROR (BC)",3X,F10.3,F5.,4X,F10.3)
      CALL CLOSE(IB)
      STOP
      END
      END$
```

AV33 (RBF-P,Q,R) (Three-way ANOVA, Repeated Measures)

Purpose:

This program performs a three-way randomized factorial block analysis of variance.

Mathematical Model:

The model for this design is:

$$X_{ijm} = u + A_i + B_j + C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + \pi_m + E_{ijkm}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $C_k = 0$ for all k

Ho: $AB_{ij} = 0$ for all ij

Ho: $AC_{ik} = 0$ for all ik

Ho: $BC_{jk} = 0$ for all jk

Ho: $ABC_{ijk} = 0$ for all ijk

The fixed effect (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A_1				A_2			
B_1		B_2		B_1		B_2	
C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2
S_1	S_1	S_1	S_1	S_1	S_1	S_1	S_1

S represents a set of subjects

1. There are two Factors (A, B, C) with p, q, and r levels of treatments, respectively. The experiment consists of pqr treatment combinations. The above example includes two levels of each of Factors A, B, and C.

2. Subjects are randomly assigned to the pqr treatment combinations with each subject or a set of matched subjects receiving all combinations. The order of administration of the pqr combination is randomized independently for each subject. If sets of matched subjects are used, one subject from each set is randomly assigned to each treatment combination.

3. There should be more than one subject per pqr treatment combination.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, Factor C varies most rapidly, then Factor B, then subjects, and finally Factor A. (For example, record one contains subject one, treatments abc_{111}, abc_{112} . . ., abc_{11r}; record two contains subject one, treatments abc_{121}, abc_{122} . . ., abc_{12r}; records continue for subject one until abc_{1q1}, abc_{1q2} . . ., abc_{1qr} have been entered. The remaining subjects in Factor A should be entered in the same manner. Repeat the same procedures for subjects in Factor A_p.) A printout of the raw data would show r data points per line.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of Factor A (see comments)

   b. number of levels of Factor B (see comments)

   c. number of levels of Factor C (see comments)

   d. number of subjects per cell (treatment combination) (see comments)

   e. name of data file

   f. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\bar{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the number of subjects necessary for the experiment.

Due to the limited amount of memory, the experimental design cannot exceed the following conditions:

1. $p \leq 10$; $q \leq 10$; $r \leq 10$

2. $n \leq 50$

3. $nqr \leq 1000$

4. $rn \leq 100$

5. $qn \leq 100$

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 239-240.

Single precision was used for this program. Accuracy of this program is less than that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences. The data analysis output is only accurate to six digit places instead of ten digits.

```
 RU,AV33
RBF-P,Q,R  OR  AV33
      THREE WAY ANOVA WITH REPEATED MEASURES ON ALL FACTORS.
ENTER NAME OF DATA FILE
#JRBFR
 ENTER FORMAT OF DATA
(2(2X,F8.4))


 LEVELS OF A
2
 LEVELS OF B
2
 LEVELS OF C
2
 SS/CELL
4
ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER
6
DO YOU WISH A PRINTOUT OF RAW DATA (1=YES, Ø=NO)
Ø
:
```

CELL	N	SUMX	SUMX2	MEAN	SD
1 1 1	4	15.000	63.000	3.750	1.500
1 1 2	4	16.000	66.000	4.000	.816
1 2 1	4	28.000	198.000	7.000	.816
1 2 2	4	32.000	258.000	8.000	.816
2 1 1	4	7.000	13.000	1.750	.500
2 1 2	4	12.000	38.000	3.000	.816
2 2 1	4	22.000	122.000	5.500	.577
2 2 2	4	40.000	402.000	10.000	.816

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	3.125	1	3.125	4.953	.035
B	162.000	1	162.000	256.755	.000
C	24.500	1	24.500	38.830	.000
AB	6.125	1	6.125	9.708	.005
AC	10.125	1	10.125	16.047	.000
BC	8.000	1	8.000	12.679	.000
ABC	3.125	1	3.125	4.953	.035
RESIDUAL	13.250	21.	.631		
TOTAL	235.500	31.			

```
*AV33  T=00003 IS ON CR00002 USING 00024 BLKS R=0000

FTN4,L
      PROGRAM AV33
      DOUBLE PRECISION SJJ(10),SKK(10),SLL(50),PQQ(10),CK(10)
      DOUBLE PRECISION DXX(100)
      DOUBLE PRECISION CBB(10),ACC(10),BSS(100),CSS(100),SCC(600),
     $SSS(50),X,XS,SX,BX,SI,BA,CA,A,AS,AB,CB,AC,BC,SS,B,C,XN,XBAR,
     $SD,Z,O,O1,ZJ,ZI,ZM,ZZJ,ZZL,ZZM,XK,XKK,ZEE,P1,P2,ZZ,ZO,ZK1,ZK2
      DOUBLE PRECISION SX1(600),SX2(600),XR(20)
      DIMENSION NFILE(3),IFMT(20),IBUF(256),IB(272)
      INTEGER P,Q,R
      DATA SX/600*0.D0/,SX2/600*0.D0/
      DATA SJJ,SKK,SLL,PQQ,CK,DXX/190*0.D0/
      DATA CBB,ACC,BSS,CSS,SCC,SSS/870*0.D0/
      DATA XS,SX,BX,SI,BA,CA,A,AS,AB,AC,BC,SS,B,C/14*0.D0/
      WRITE(1,4400)
4400  FORMAT ("R9F-P,Q,R  OR AV33 ",
     $/,5X,"THREE WAY ANOVA WITH REPEATED MEASURES ON ALL ",
     #" FACTORS.")
      WRITE(1,4401)
4401  FORMAT("ENTER NAME OF DATA FILE")
      READ(1,7) NFILE
7     FORMAT(3A2)
      WRITE(1,4402)
4402  FORMAT ( " ENTER FORMAT OF DATA " )
      READ(1,6)IFMT
6     FORMAT(20A2)
      CALL OPEN(IB,IER,NFILE,3,0,-2,256)
      IF(IER.LT.0) GO TO 999
      WRITE(1,4403)
4403  FORMAT ( " LEVELS OF A ")
      READ(1,*)  P
      WRITE(1,4404)
4404  FORMAT ( " LEVELS OF B ")
      READ(1,*)  Q
      WRITE(1,4405)
4405  FORMAT ( " LEVELS OF C ")
      READ(1,*)  R
      WRITE(1,4406)
4406  FORMAT ( " SS/CELL ")
      READ(1,*)  N
      O=Q*R*N
      WRITE(1,224)
224   FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER")
      READ(1,*) IUNIT
      WRITE(1,223)
223   FORMAT("DO YOU WISH A PRINTOUT OF RAW DATA (1=YES, 0=NO)")
      READ(1,*) IPTO
      DO 90 I=1,P
      DO 440 L=1,N
      DO 520 J=1,Q
      CALL READF(IB,IER,IBUF)
      CALL CODE
```

```
      READ(IBUF,IFMT) (XR(I3),I3=1,R)
      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (XR(I2),I2=1,R)
      DO 695 K=1,R
      X=XR(K)
      III=(I-1)*Q*R + (J-1)*R +K
      SX2(III)=SX2(III) + X*X
      SX1(III)=SX1(III)+X
      XS=XS + X*X
      SX=SX + X
      BX=BX+X
      SI=SI+X
      SJJ(J)=SJJ(J)+X
      SKK(K)=SKK(K)+X
      SLL(L)=SLL(L)+X
      PQQ(J)=PQQ(J)+X
      CK(K)=CK(K)+X
      II=J+Q*(K-1)
      DXX(II)=DXX(II)+X
      CBB(II)=CBB(II)+X
      ACC(K)=ACC(K)+X
      II=J+Q*(L-1)
      BSS(II)=BSS(II)+X
      II=K+R*(L-1)
      CSS(II)=CSS(II)+X
      M=M+1
      SCC(M)=SCC(M)+X
695   SSS(L)=SSS(L)+X
      BA=BA+BX*BX/R
520   BX=0
      DO 440 K=1,R
      CA=CA+CK(K)*CK(K)/Q
440   CK(K)=0
      A=A+SI*SI/(Q*R*N)
      SI=0
      DO 390 L=1,N
      AS=AS+SLL(L)*SLL(L)/(Q*R)
390   SLL(L)=0
      DO 930 J=1,Q
      AB=AB+PQQ(J)*PQQ(J)/(R*N)
      PQQ(J)=0
      DO 930 K=1,R
      II=J+Q*(K-1)
      CB=CB+CBB(II)*CBB(II)/N
930   CBB(II)=0
      DO 820 K=1,R
      AC=AC+ACC(K)*ACC(K)/(N*Q)
      ACC(K)=0
820   M=0
90    CONTINUE
      DO 1120 J=1,Q
      DO 1120 K=1,R
      II=J+Q*(K-1)
      BC=BC+DXX(II)*DXX(II)/(P*N)
1120  CONTINUE
```

```
      DO 1040 L=1,N
      SS=SS+SSS(L)*SSS(L)/(P*Q*R)
 1040 CONTINUE
      DO 1240 J=1,Q
      B=B+SJJ(J)*SJJ(J)/(P*R*N)
 1240 CONTINUE
      DO 1250 K=1,R
      C=C+SKK(K)*SKK(K)/(P*Q*N)
 1250 CONTINUE
      X=SX*SX/(P*Q*R*N)
      WRITE(IUNIT,225)
 225  FORMAT(////,"0   CELL",5X,"N",11X,"SUMX",7X,"SUMX2",7X,"MEAN",
     17X,"SD",/)
      XN=N
      DO 226 I=1,P
      DO 226 J=1,Q
      DO 226 K=1,R
      III=(I-1)*Q*R +(J-1)*R +K
      XBAR=SX1(III)/XN
      SD=DSQRT((SX2(III)-(SX1(III)*SX1(III))/XN)/(XN-1.))
      WRITE(IUNIT,227) I,J,K,N,SX1(III),SX2(III),XBAR,SD
 227  FORMAT(3I2,3X,I4,3X,4(1X,F10.3))
 226  CONTINUE
      WRITE(IUNIT,2011)
 2011 FORMAT(1X,//,"                              SOURCE TABLE"
     ///,1X,"SOURCE          SS         DF          MS             F",
     112X,"P(F)",/)
      Z=XS+X-SS-CB
      O=(N-1)*(P*Q*R-1)
      O1=O
      ZJ=A-X
      K=P-1
      ZI=Z/O
      ZL=ZJ/K
      ZM=ZL/ZI
      ZZJ=B-X
      KK=Q-1
      ZZL=ZZJ/KK
      ZZM=ZZL/ZI
      XK=K
      XKK=KK
      CALL FPROB(ZM,XK,O1,ZEE,P1)
      CALL FPROB(ZZM,XKK,O1,ZEE,P2)
      WRITE(IUNIT,3110)ZJ,K,ZL,ZM,P1,ZZJ,KK,ZZL,ZZM,P2
 3110 FORMAT(1X,"  A           ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6,
     //"   B           ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6)
      ZJ=C-X
      K=R-1
      ZL=ZJ/K
      ZM=ZL/ZI
      ZZJ=AB+X-A-B
      KK=(P-1)*(Q-1)
      ZZL=ZZJ/KK
      ZZM=ZZL/ZI
```

```
      XK=K
      XKK=KK
      CALL FPROB(ZM,XK,01,ZEE,P1)
      CALL FPROB(ZZM,XKK,01,ZEE,P2)
      WRITE(IUNIT,2310)ZJ,K,ZL,ZM,P1,ZZJ,KK,ZZL,ZZM,P2
2310  FORMAT(1X," C           ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6,
     //"  AB          ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6)
      ZJ=AC+X-A-C
      K=(P-1)*(R-1)
      ZL=ZJ/K
      ZM=ZL/ZI
      ZZJ=BC+X-B-C
      KK=(Q-1)*(R-1)
      ZZL=ZZJ/KK
      ZZM=ZZL/ZI
      ZK1=K
      ZK2=KK
      CALL FPROB(ZM,ZK1,01,ZEE,P1)
      CALL FPROB(ZZM,ZK2,01,ZEE,P2)
      WRITE(IUNIT,2510)ZJ,K,ZL,ZM,P1,ZZJ,KK,ZZL,ZZM,P2
2510  FORMAT(1X," AC          ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6
     //"  BC          ",F8.3 5X,I3,2(5X,F8.3),3X,F10.6)
      ZJ=CB+A+B+C-X-AB-AC-BC
      K=K*(P-1)
      ZL=ZJ/K
      ZM=ZL/ZI
      ZZ=XS-X
      ZO=N*P*Q*R-1
      XK=K
      CALL FPROB(ZM,XK,01,ZEE,P1)
      WRITE(IUNIT,2710)ZJ,K,ZL,ZM,P1,Z,O,ZI,ZZ,ZO
2710  FORMAT(1X,"ABC          ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6,
     //" RESIDUAL  ",F10.3,F8.0,5X,F8.3
     ///" TOTAL       ",F8.3,1X,F8.0,5X,F8.3,//)
      CALL CLOSE(IB,IER)
      GO TO 987
999   WRITE(1,4408)
4408  FORMAT (  "ERROR ON CALL OPEN STATEMENT"  )
987   END
      END$
```

AC10 (CRAC) (One-way Analysis of Covariance)

Purpose:

This program performs a one-way analysis of covariance for one covariate without replication.

Mathematical Model:

The model of this design is:

$$Y_{ij(adj)} = Y_{ij} - B'_w (X_{ij} - \overline{X}..) = u + B_j + \varepsilon_{i(j)}$$

where:

Y_{ij} = unadjusted criterion measure

B'_w = common population linerar regression coefficient for treatment levels

X_{ij} = covariate measure for subject i in treatment population j

The hypothesis to be tested is:

Ho: Bj = 0 for all j

The fixed effect model (Model I) was assumed in the deviation of the expected values of the mean squares.

Layout of Design:

b_1		b_2		b_k	
Y	X	Y	X	Y	X
S_1		S_2		S_j	

1. There are k levels of treatment B.

2. Subjects are randomly assigned with each subject designated to receive only one level.

3. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.

4. The relationship of the dependent variable and the covariate must be linear.

User Considerations and Procedures:

1. A data file must be created in sequential form. For each subject, enter the dependent measure (Y) first, then the covariate (X). (For example, subject one for treatment b_1, and the covariate is the first record, subject two for treatment b_1, and the covariate is the second record. Repeat for all subjects in b_1 then index to the next level of B.) A printout of raw data should show two data points per line.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of B (maximum 100)

   b. number of subjects per group (level) (maximum 32767)

   c. name of data file

   d. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σy, Σy^2, $\bar{Y}$, SD

   c. ANOVA source table

   d. intermediate calculations of the adjusted scores

   e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependent variable. With analysis of covariance, the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on printout of the data must be used to adjust the means. Computational procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp.465-472.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 465-467. This program uses double precision in all calculations.

```
 RU,AC10
CRAC-K OR AC10 ANALYSIS OF COVARIANCE
    NOTE:  PROGRAM EXPECTS DATA IN ONE SEQUENTIAL FILE
           INDEXING FOR SUBJECTS, FIRST THEN, GROUPS -
           WITH TWO POINTS PER LINE DEPENDENT VARIABLE THEN COVARIATE
 ENTER NAME OF YOUR FILE FROM DATA30 PROGRAM
 #JACOV
 ENTER THE RECORD LENGTH AS IN DA30
28
 ENTER FORMAT OF DATA
(2(4X,F10.4))
 HOW MANY GROUPS?
4
 HOW MANY SUBJECTS/GROUPS?
8
 ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0
1
 ENTER 1 FOR CRT DISPLAY, OR 6 FOR LINEPRINTER
6
  AC10  :  STOP  0000
:
```

3.0000	42.0000
6.0000	57.0000
3.0000	33.0000
3.0000	47.0000
1.0000	32.0000
2.0000	35.0000
2.0000	33.0000
2.0000	39.0000
4.0000	47.0000
5.0000	49.0000
4.0000	42.0000
3.0000	41.0000
2.0000	38.0000
3.0000	43.0000
4.0000	48.0000
3.0000	45.0000
7.0000	61.0000
3.0000	65.0000
7.0000	64.0000
6.0000	56.0000
5.0000	52.0000
6.0000	58.0000
5.0000	53.0000
6.0000	54.0000
7.0000	65.0000
8.0000	74.0000
9.0000	80.0000
8.0000	73.0000
10.0000	85.0000
10.0000	82.0000
9.0000	78.0000
11.0000	89.0000

Y-TERMS (DEP. VAR.)

(BS)	1160.000
(Y)	924.500
(B)	1119.000

X-TERMS (COVAR.)

(BS)	105202.000
(X)	96800.000
(B)	103997.250

XY-TERMS

(BS)	10840.000
(XY)	9460.000
(B)	10637.750

CELL	N	SUMX	SUMX2	MEAN	SD
1	8	22.000	76.000	2.750	1.488
2	8	28.000	[illegible].000	3.500	.926
3	8	50.000	320.000	6.250	1.035
4	8	72.000	660.000	9.000	1.309

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
TOTAL	8.840	30.			
BETWEEN GRPS	1 793	3.00	.598	2.290	.100
WITHIN GRPS	7.047	27.	.261		

CORRELATION COEFFICIENTS

BETWEEN GRPS	.995
WITHIN GRPS	.910
TOTAL	.981

```
*AC10  T=00003 IS ON CR00002 USING 00019 BLKS R=0000

FTN4
      PROGRAM AC10
      DIMENSION NFILE(3),IFMT(20)
      DOUBLE PRECISION X,Y,SX,SY,YS,XS,GX,GY,XB,YB,GG,X2,SS,C,D,ZI
      DOUBLE PRECISION ZJ,ZN,ZNJ,BN,BNK1,BN2,QN,XN,Y2,XY
      DIMENSION IB(272),IBUF(256)
      DOUBLE PRECISION SUMX(100),SUMX2(100)
      SX=0.
      SY=0.
      XY=0.
      YS=0.
      XS=0.
      GX=0.
      XB=0.
      YB=0.
      GG=0.
      WRITE(1,4400)
4400  FORMAT ( "CRAC-K  OR AC10  ANALYSIS OF COVARIANCE " ,
     $/,5X,"NOTE: PROGRAM EXPECTS DATA IN ONE SEQUENTIAL FILE",
     %/,11X,"INDEXING FOR SUBJECTS , FIRST THEN, GROUPS -  ",/,
     &11X,"WITH TWO POINTS PER LINE   DEPENDENT  VARIABLE THEN ",
     #"COVARIATE.  ",11X," MAX 100 GROUPS")
      WRITE(1,4401)
4401  FORMAT ( "ENTER NAME OF YOUR FILE FROM DATA30 PROGRAM"  )
      READ(1,99)NFILE
99    FORMAT(3A2)
      IDCBS=256
      CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
      IF(IER.GE.0) GO TO 689
      WRITE(1,345) NFILE,IER
345   FORMAT(5X,3A2," FAILED TO OPEN , IER = ",I5)
      STOP 345
689   WRITE(1,4402)
4402  FORMAT ( "ENTER FORMAT OF DATA" )
      READ(1,6)IFMT
6     FORMAT(20A2)
      WRITE(1,4403)
4403  FORMAT ( " HOW MANY GROUPS?  ")
      READ(1,*) K
      WRITE(1,4404)
4404  FORMAT ( " HOW MANY SUBJECTS/GROUP?  ")
      READ(1,*) N
      BN=N*K
      XN=N
      WRITE(1,9001)
9001  FORMAT("ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0")
      READ(1,*) IPTO
      WRITE(1,1234)
1234  FORMAT("ENTER 1 FOR CRT DISPLAY, OR 6 FOR LINEPRINTER")
      READ(1,*) IUNIT
      DO230 I=1,K
```

```
      IF(IPTO.EQ.1) WRITE(IUNIT,903)
903   FORMAT(//)
      DO330 J=1,N
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)Y,X
      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
      SX=SX+X
      SUMX(I)=SUMX(I)+Y
      SUMX2(I)=SUMX2(I)+Y*Y
      SY=SY+Y
      XY=XY+X*Y
      YS=YS+Y*Y
      XS=XS+X*X
      GX=GX+X
330   GY=GY+Y
3109  FORMAT(//)
      XB=XB+GX*GX/XN
      YB=YB+GY*GY/XN
      GG=GG+GX*GY/XN
      Y=GY/XN
      X=GX/XN
      GX=0
      GY=0
230   CONTINUE
      Y2=SY*SY/BN
      X2=SX*SX/BN
      SS=SY*SX/BN
      WRITE(IUNIT,600)
600   FORMAT(1X,//)
      WRITE(IUNIT,161)YS,Y2
161   FORMAT(1X,"Y-TERMS(DEP. VAR.) ",/," (BS) ",F12.3,/,1X,"(Y)",2X,
     $F12.3)
      WRITE(IUNIT,171)YB
171   FORMAT(" (B)",2X,F12.3,//,1X,"X-TERMS(COVAR.)")
      WRITE(IUNIT,1711)XS,X2
1711  FORMAT(1X,"(BS)",1X,F12.3,/,1X,"(X)",2X,F12.3)
      WRITE(IUNIT,181)XB,XY,SS,GG
181   FORMAT(" (B)",2X,F12.3,//,1X,"XY-TERMS",/,1X,"(BS)",1X,F12.3,/,
     X1X,"(XY)",1X,F12.3,/,1X,"(B) ",1X,F12.3)
      WRITE(IUNIT,453)
453   FORMAT(////,"0  CELL",4X,"N",7X,"SUMX",6X,"SUMX2",9X,"MEAN",
     110X,"SD",/)
      DO228 I=1,K
      XB1=SUMX(I)/XN
      SD1=DSQRT((SUMX2(I)-(SUMX(I)*SUMX(I))/XN)/(XN-1))
      WRITE(IUNIT,229) I,N,SUMX(I),SUMX2(I),XB1,SD1
229   FORMAT(1X,I3,3X,I3,4(3X,F10.3))
228   CONTINUE
      C=YS-Y2-(XY-SS)*(XY-SS)/(XS-X2)
      D=YS-YB-(XY-GG)*(XY-GG)/(XS-XB)
      ZI=C-D
      ZJ=D/(BN-K-1)
      ZN=ZI/(K-1)
      WRITE(IUNIT,531)
```

```
531   FORMAT(1X,//,17X,"SOURCE TABLE")
      WRITE(IUNIT,536)
536   FORMAT(1X,/,4X,"SOURCE",11X,"SS",8X,"DF",9X,"MS",9X,"F",9X,
     1"P(F)")
      K1=K-1
      ZNJ=ZN/ZJ
      BNK1=BN-K-1
      BN2=BN-2
      WRITE(IUNIT,700)C,BN2
700   FORMAT(1X,"TOTAL",7X,F12.3,5X,F4.0)
      DF1=K1
      DF2=BNK1
      F=ZNJ
      CALL FPROB(F,DF1,DF2,Z3,PF1)
      WRITE(IUNIT,541)ZI,K1,ZN,ZNJ,PF1
541   FORMAT(/,1X,"BETWEEN GRPS",F12.3,4X,F4.3,3(5X,F7.3),/)
      WRITE(IUNIT,551)D,BNK1,ZJ
551   FORMAT(1X,"WITHIN GRPS",1X,F12.3,5X,F4.0,4X,F7.3)
      C=(XY-SS)/DSQRT((XS-X2)*(YS-Y2))
      D=(GG-SS)/DSQRT((XB-X2)*(YB-Y2))
      QN=(XY-GG)/DSQRT((XS-XB)*(YS-YB))
      WRITE(IUNIT,571)
571   FORMAT(1X,//," CORRELATION COEFFICIENTS ")
      WRITE(IUNIT,581)D,QN
581   FORMAT(2X,/,1X,"BETWEEN GRPS",F9.3,/,1X,"WITHIN GRPS",1X,F9.3)
      WRITE(IUNIT,5811)C
5811  FORMAT(4X,"TOTAL  ",2X,F9.3,/)
      CALL CLOSE(IB,IER)
      STOP
      END
      END$
```

AC11 (RBAC-K) (One-way Analysis of Covariance, Repeated Measures)

Purpose:

This program performs a one-way analysis of covariance for one covariate with replication either by using matched subjects or repeated measures.

Mathematical Model:

The model for this design is:

$$Y_{ij(adj)} = Y_{ij} - B'_w(X_{ij} - \bar{X}_{..}) = u + B_j + \tau_i + E_{ij}$$

where:

Y_{ij} = readjusted criterion measure

B'_w = common populaton linear regression coefficient for treatment levels

The hypothesis to be tested is:

Ho: $B_j = 0$ for all j

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

b_1		b_2		b_k	
Y	X	Y	X	Y	X
S_1		S_1		S_1	

S represents a set of subjects

1. There are k levels of treatment B.

2. Subjects are assigned to a treatment so that the variability within a treatment is less than the variability among treatments. Homogeneity within treatments may be achieved by using a subject as his own control or match subjects on the basis of a variable that correlates with the dependent variable.

3. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.

4. The relationship of the dependent variable and the covariate is linear.

5. For repeated measures, the dependent measure for each subject is paired with a unique covariate measure. The covariate cannot be identical for all measures, e.g., age of a subject.

User Considerations and Procedures:

1. A data file must be created in sequential form, with the dependent measure (Y) first, then the covariate (X). (For example, subject one for treatment b_1 and the covariate is the first record, subject two for treatment b_1 and the covariate is the second record. Follow this procedure for all subjects in b_1 then index to the next level of B.) A printout of raw data shows two data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of B (maximum 100)

   b. number of subjects per group (level) (maximum 32767)

   c. name of data file

   d. format of data file

   e. correlation coefficients

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σy, Σy^2, $\overline{Y}$, SD

c. ANOVA source table

d. intermediate calculations of the adjusted scores

e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependnet variable. With analysis of covariance, the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on the printout of the data must be used to adjust the means. Computational procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavorial Sciences, Wadsworth Publishing Company, 1968. Pp. 475-477.

Test Data:

This program was tested by comparing the results of the AC11 program to results obtained from a similar PDP 8/e Analysis of Covariance program. The program uses double precision in all calculations.

```
RU,AC11
AC11 OR
REAC-K   ONE-WAY ANALYSIS OF COVARIANCE FOR
         REPEATED MEASURES.  DATA INPUT READ SEQUENCE
         INDEX FOR SUBJECTS, THEN FOR WITHIN FACTOR.  ENTER THE
         DEPENDENT VARIABLE, THEN THE COVARIATE
ENTER NAME OF THE DATA FILE
#JRBAC
 ENTER FORMAT OF DATA
(2(2X,F8.4))
 HOW MANY TREATMENTS?
4
 HOW MANY SUBJECTS?
6
 ENTER THE RECORD LENGTH AS IN DA3Ø
2Ø
ENTER 1 FOR RAW DATA PRINTOUT (1=YES)
1
ENTER 1 FOR CRT PRINTOUT, 6 FOR LPTR
6
  AC11  :  STOP   ØØØØ
:
```

202.0000	28.0000		
145.0000	23.0000		
188.0000	27.0000		
201.0000	24.0000		
202.0000	30.0000		
228.0000	30.0000		
MEAN-Y	194.333	MEAN-X	27.000
165.0000	22.0000		
201.0000	26.0000		
185.0000	24.0000		
231.0000	28.0000		
178.0000	26.0000		
221.0000	25.0000		
MEAN-Y	196.833	MEAN-X	25.167
191.0000	27.0000		
203.0000	28.0000		
185.0000	27.0000		
238.0000	30.0000		
198.0000	26.0000		
207.0000	27.0000		
MEAN-Y	203.667	MEAN-X	27 500
134.0000	19.0000		
180.0000	24.0000		
220.0000	28.0000		
261.0000	30.0000		
226.0000	29.0000		
204.0000	24.0000		
MEAN-Y	204.167	MEAN-X	25.667

Y-TERMS (DEP. VAR.)

(BS)	976280.000
(Y)	957601.500
(B)	958037.667
(S)	967091.500

X-TERMS (COVAR.)

(BS)	16824.000
(Y)	16642.667
(B)	16664.333
(S)	16688.500

Y-TERMS

(BS)	127727.000
(XY)	126242.000
(B)	126250.500
(S)	126801.250

CELL	N	SUMX	SUMX2	MEAN	SD
1	6	1166.000	230362.000	194.333	27.457
2	6	1181.000	235737.000	196.833	25.600
3	6	1222.000	250612.000	203.667	18.608
4	6	1225.000	259569.000	204.167	43.508

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
TREATMENT	1502.394	3.	500.798	5.150	.0132
BLOCKS	3227.275	5.	645.455	6.638	.0026
RESIDUAL	1361.286	14.	97.235		
TOTAL	6517.333	22.			

CORRELATION COEFFEC ENTS

TREATMENTS	.087
BLOCKS	.848
RESIDUAL	.919
TOTAL	.807

```
*AC11  T=0000  IS ON CR00002 USING 00022 BLKS R=0000

FTN4
      PROGRAM AC11
      REAL K1,K1X1
      DOUBLE PRECISION S1A,S2A,X,Y,SX,SY,YS,XS,GX,X2,GY
      DOUBLE PRECISION XB,YB,GG,ZK,S1,S2,SS,Y2,C,ZJ,ZI,D,ZI1,ZN
      DOUBLE PRECISION GXB,XB,SD,X1,X3,XN
      DOUBLE PRECISION S1A(100),S2A(100),X1(100),X3(100)
      DIMENSION NFILE(3),IFMT(20),IB(272),IBUF(256)
      WRITE(1,4399)
4399  FORMAT(" AC11 OR ",/,
     C" RBAC-K   ONE-WAY ANALYSIS OF COVARIANCE FOR ",/,
     $"          REPEATED MEASURES.  DATA INPUT READ SEQUENCE",/,
     %10X,"INDEX FOR SUBJECTS, THEN FOR WITHIN FACTOR. ENTER THE",/,
     &10X,"DEPENDENT VARIABLE, THEN THE COVARIATE")
      WRITE(1,987)
987   FORMAT("ENTER NAME OF THE DATA FILE")
      READ(1,16)NFILE
16    FORMAT(3A2)
      WRITE(1,4401)
4401  FORMAT ( " ENTER FORMAT OF DATA " )
      READ(1,6)IFMT
6     FORMAT(20A2)
      WRITE(1,4402)
4402  FORMAT ( " HOW MANY TREATMENTS?  ")
      READ(1,*) K
      WRITE(1,4403)
4403  FORMAT ( " HOW MANY SUBJECTS?  ")
      READ(1,*) N
      IDCBS=256
      CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
      IF (IER.LT.0) GO TO 999
      WRITE(1,154)
154   FORMAT("ENTER 1 FOR RAW DATA PRINTOUT(1=YES)")
      READ(1,*) IPTO
      WRITE(1,912)
912   FORMAT("ENTER 1 FOR CRT PRINTOUT, 6 FOR LPTR")
      READ(1,*) IUNIT
      BN=N*K
      XN=N
      DO 230 I=1,K
      DO 330 J=1,N
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) Y,X
      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
      SX=SX+X
      X1(I)=X1(I)+Y
      X3(I)=X3(I)+Y*Y
      SY=SY+Y
```

```
       XY=XY+X*Y
       YS=YS+Y*Y
       XS=XS+X*X
       GX=GX+X
       GY=GY+Y
       S1A(J)=S1A(J)+Y
 330   S2A(J)=S2A(J)+X
       XB=XB+GX*GX/XN
       YB=YB+GY*GY/XN
       GG=GG+GX*GY/N
       GY=GY/N
       GX=GX/N
       WRITE(IUNIT,231)GY,GX
 231   FORMAT(1X," MEAN-Y ",F10.3,4X," MEAN-X ",F10.3)
       GX=0
       GY=0
 230   CONTINUE
       DO 190 J=1,M
       ZK=K
       S1=S1+S1A(J)*S1A(J)/ZK
       S2=S2+S2A(J)*S2A(J)/ZK
 190   S3=S3+S1A(J)*S2A(J)/ZK
       Y2=SY*SY/BN
       X2=SX*SX/BN
       SS=SY*SX/BN
       WRITE(IUNIT,600)
 600   FORMAT(1X,//)
       WRITE(IUNIT,161)YS,Y2
 161   FORMAT(1X,"Y-TERMS(DEP. VAR.) ",/," (BS) ",F12.3,/,1X,"(Y)",2X,
      1F12.3)
       WRITE(IUNIT,171)YB,S1
 171   FORMAT(" (B)",2X,F12.3,/," (S)",2X,F12.3,//,1X,
      C"X-TERMS(COVAR.)")
       WRITE(IUNIT,1711)XS,X2
 1711  FORMAT(1X,"(BS)",1X,F12.3,/,1X,"(X)",2X,F12.3)
       WRITE(IUNIT,181)XB,S2,XY,SS,GG
 181   FORMAT(" (B)",2X,F12.3,/," (S)",2X,F12.3,//,"XY-TERMS",/,
      X" (BS)",1X, F12.3,/,1X,"(XY)",1X,F12.3,/,1X,"(B) ",1X,F12.3)
       WRITE(IUNIT,1811)S3
 1811  FORMAT(" (S)",2X,F12.3)
       C=YS-Y2-(XY-SS)*(XY-SS)/(XS-X2)
       ZJ=YS+Y2-YB-S1
       X=XS+X2-XB-S2
       ZI=XY+SS-GG-S3
       D=ZJ-ZI*ZI/X
       Y=S1-Y2+ZJ-(S3-SS+ZI)*(S3-SS+ZI)/(S2-X2+X)-D
       ZI1=YB-Y2+ZJ-(GG-SS+ZI)*(GG-SS+ZI)/(XB-X2+X)-D
       X=N-1
       GY=Y/X
       ZJ=D/((K-1)*X-1)
       ZN=ZI1/(K-1)
       WRITE(IUNIT,703)
 703   FORMAT(////,"0  CELL",4X,"N",7X,"SUMX",6X,"SUMX2",6X,"MEAN",
      111X,"SD",/)
```

```
        XN=N
        GXB=XB
        DO 704 I=1,K
        XB=X1(I)/XN
        SD=DSQRT((X3(I)-(X1(I)*X1(I))/XN)/(XN-1.))
704     WRITE(IUNIT,709) I,N,X1(I),X3(I),XB,SD
709     FORMAT(2I5,1X,4(3X,F10.3))
        WRITE(IUNIT,531)
531     FORMAT(1X,//,17X,"SOURCE TABLE")
        GX=GY/ZJ
        XB=GXB
        K1=K-1
        K1X1=(K-1)*X-1.
        ZNJ=ZN/ZJ
        CALL FPROB(ZNJ,K1,K1X1,ZT1,PF1)
        DF1=X
        GX1=GX
        CALL FPROB(GX1,DF1,K1X1,ZT2,PF2)
        WRITE(IUNIT,536)
536     FORMAT(1X,/,4X,"SOURCE",11X,"SS",8X,"DF",9X,"MS",9X,"F",
       18X,"P(F)",//)
        WRITE(IUNIT,541)ZT1,K1,ZN,ZNJ,PF1
541     FORMAT(1X,"TREATMENT    ",3X,F9.3,F7.0,6X,F7.3,3X,F7.3,3X,F7.4)
        WRITE(IUNIT,542)Y,X,GY,GX,PF2
542     FORMAT(1X,"BLOCKS        ",2X,F9.3,1X,F7.0,5X,F7.3,3X,F7.3,
       13X,F7.4)
C       RESIDUAL
        K1X1=(K-1)*X-1
        WRITE(IUNIT,545)D,K1X1,ZJ
545     FORMAT(1X,"RESIDUAL      ",2X,F9.3,F7.0,4X,F9.3)
        BN2=BN-2
        WRITE(IUNIT,551)C,BN2
551     FORMAT(1X,"TOTAL",8X,F12.3,4X,F .0)
        X=(S3-SS)/DSQRT((S1-Y2)*(S2-X2))
        C=(XY-SS)/DSQRT((XS-X2)*(YS-Y2))
        D=(GG-SS)/DSQRT((XB-X2)*(YB-Y2))
        ZN=(XY+SS-GG-S3)/DSQRT((YS+Y2-YB-S1)*(XS X2-XB-S2))
        WRITE(IUNIT,581)D
581     FORMAT(1X,//,1X,"CORRELATION COEFFECIENTS",//," TREATMENTS",2X,
       1F5.3)
        WRITE(IUNIT,582)X,ZN,C
582     FORMAT(" BLOCKS",6X,F5.3,/," RESIDUAL  ",2X,F5.3,/," TOTAL    ",
       24X,F5.3)
        CALL CLOSE(IB,IER)
        STOP
999     WRITE(1,4408)
4408    FORMAT (  " ERROR ON CALL OPEN STATEMENT "  )
        STOP
        END
        END$
```

AC20 (CRFAC-P,Q) (Two-way Analysis of Covariance)

Purpose:

This program performs a two-way analysis of covariance for one covariate without replication.

Mathematical Model:

The model of this design is:

$$Y_{ijm(adj)} = Y_{ijm} - B'_w + (X_{ijm} - \overline{X}...) = u + A_i + B_j + AB_{ij} + E_{m(ij)}$$

where:

Y_{ij} = unadjusted criterion measure

B'_w = common population linear regression coefficient for treatment levels

X_{ij} = covariate measure for subject i in treatment population j

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $AB_{ij} = 0$ for all ij

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A_1		A_2		A_3	
B_1 X Y	B_2 X Y	B_1 X Y	B_2 X Y	B_1 X Y	B_2 X Y
S_1	S_2	S_3	S_4	S_5	S_6

S represents a set of subjects

1. There are two Factors (A,B) with p and q levels of treatments, respectively. The experiment consists of pq treatment combinations. The above example includes three levels of Factor A, two levels of Factor B.

2. Subjects are randomly assigned to the pq treatment combinations, with each subject receiving only one combination.

3. There should be more than one subject per pq treatment combination.

4. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.

5. The relationship of the dependent variable and the covariate is linear.

User Considerations and Procedures:

1. A data file must be created in sequential form with the dependent variable (Y) first, then the covariate (X). On read, indexing for subjects comes first, then for Factor B, and finally Factor A. (For example, first record is subject one for treatment and covariate of ab_{11}, second record is subject two for treatment and covariate of ab_{11}; continue for all subjects in treatment ab_{11}. Next, enter all subjects for treatment ab_{12}; repeat for ab_{1q}. Then enter data for ab_{21}. . ., the final record would be subject n for treatment ab_{pq}.) A printout of the raw data would show two data points per line.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of Factor A (see comments)

   b. number of levels of Factor B (see comments)

   c. number of subjects per AB cell (maximum 32767) (see comments)

   d. name of the data file

   e. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σy, Σy^2, $\overline{Y}$, SD

   c. ANOVA source table

   d. intermediate calculations of the adjusted scores

   e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependent variable. With analysis of the covariance the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on the printout of the data must be used to adjust the means. Computation procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 479-482.

This program has the following restrictions:

1. The number of subjects per AB treatment combinations should be equal.

2. There cannot be more than 400 treatment combinations ($p*q \leqslant 400$).

Test Data:

This program was tested by comparing the results of the AC20 program to results obtained from a similar PDP 8/e Analysis of Covariance program. The program uses double precision in all calculations.

```
 RU,AC2Ø
AC2Ø OR
CRFAC-P,Q   ANALYSIS OF COVARIANCE ON TWO FACTORS
            WITH NO REPEATED MEASURES.  ON INPUT READ SEQUENCE, INDEX
            FOR SUBJECTS FIRST, THEN FACTOR B AND FINALLY FACTOR A.
            PROGRAM EXPECTS 2 DATA POINTS PER LINE - DEPENDENT VARIABLE,
            THEN THE COVARIATE
ENTER DATA FILE NAME
#JCRFA
ENTER FORMAT OF DATA FILE
(2(2X,F8.4))
 ENTER THE RECORD LENGTH AS IN DA3Ø
2Ø
 HOW MANY LEVELS OF A?
2
 HOW MANY LEVELS OF B?
3
 HOW MANY LEVELS OF SS/CELL?
5
ENTER 1 FOR PRINTOUT OF RAW DATA, Ø IF NOT
1
ENTER 1 FOR CRT PRINTOUT, OR 6 FOR LPTR
6
  AC2Ø  :  STOP    ØØØØ
:
```

Y	X
95.0000	40.0000
80.0000	35.0000
95.0000	40.0000
105.0000	50.0000
100.0000	45.0000
85.0000	30.0000
100.0000	40.0000
85.0000	45.0000
90.0000	40.0000
90.0000	40.0000
90.0000	50.0000
85.0000	40.0000
90.0000	40.0000
80.0000	30.0000
85.0000	40.0000
100.0000	50.0000
95.0000	30.0000
95.0000	35.0000
110.0000	45.0000
88.0000	30.0000
100.0000	50.0000
90.0000	30.0000
95.0000	40.0000
90.0000	45.0000
95.0000	40.0000
95.0000	45.0000
85.0000	30.0000
75.0000	25.0000
105.0000	50.0000
85.0000	35.0000

Y-TERMS (DEPENDENT VARIABLE)

(A)	253628.9333	(B)	253939.4000	(AB)	254018.8000
(ABS)	255444.0000	(Y)	253552.1333		

X-TERMS (COVARIABLE)

(A)	46828.3333	(B)	46822.5000	(AB)	46895.0000
(ABS)	48325.0000	(X)	46807.5000		

XY-TERMS

(A)	108901.0000	(B)	109007.5000	(AB)	108979.0000
(ABS)	110065.0000	(XY)	108941.0000		

CELL		N	SUMX	SUMX2	MEAN	SD
1	1	5	475.000	45475.000	95.000	9.354
1	2	5	450.000	40650.000	90.000	6.124
1	3	5	430.000	37050.000	86.000	4.183
2	1	5	488.000	47894.000	97.600	8.142
2	2	5	470.000	44250.000	94.000	4.183
2	3	5	445.000	40125.000	89.000	11.402

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	147.423	1	147.423	5.64701	.02477
B	292.811	2	146.405	5.60802	.01036
AB	14.412	2	7.206	.27603	.76459
ERROR	600.448	23	26.106		
TOTAL	1059.329	28			

CORRELATION COEFFICIENTS

A	-1.000
B	.873
AB	.992
ERROR	.761
TOTAL	.663

```
*AC20  T=00004 IS ON CR00002 USING 00027 BLKS R=0211

FTN4
      PROGRAM AC20
      INTEGER P,Q,D
      DOUBLE PRECISION BXX(400),X,Y,SX,SY,ZS,YX,XS,SA,AS,SN,SNS,BA,XN
      DOUBLE PRECISION AB,ZZ,SNSN,SNN,AX,AY,AZ,ASQN,SAQN,PQN,SZ,BY,
     1BX,BZ,BYJPN,BXJPN,C,DD,ZI,ZZ,AYSX,BYSX,BASX,BYY(400)
      DOUBLE PRECISION PQN,QN,PN
      DIMENSION IB(272),IBUF(256),NFILE(3),IFMT(20)
      DOUBLE PRECISION SUMX(400),SUMX2(400)
      DO 897 K=1,400
      BXX(K)=0.
897   BYY(K)=0.
      WRITE(1,3999)
3999  FORMAT("AC20 OR ",/,
     C"CRFAC-P,Q   ANALYSIS OF COVARIANCE ON TWO FACTORS",/,
     $13X,"WITH NO REPEATED MEASURES. ON INPUT READ SEQUENCE, INDEX",
     %/13X,"FOR SUBJECTS FIRST, THEN FACTOR B AND FINALLY FACTOR A.",
     &/,13X,"PROGRAM EXPECTS 2 DATA POINTS PER LINE - DEPENDENT "
     B,"VARIABLE",/,13X,", THEN THE COVARIATE",/,
     C"ENTER DATA FILE NAME")
      READ(1,568) NFILE
568   FORMAT(3A2)
      WRITE(1,1456)
1456  FORMAT("ENTER FORMAT OF DATA FILE")
      READ(1,435) IFMT
      IDCBS=256
435   FORMAT(20A2)
      CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
      IF(IER.GE.0) GO TO 123
      WRITE(1,543) NFILE,IER
543   FORMAT(3A2,"  FAILED TO OPEN , IER = ",I5)
      STOP 543
123   WRITE(1,4401)
4401  FORMAT ( " HOW MANY LEVELS OF A? ")
      READ(1,*)  P
      WRITE(1,4402)
4402  FORMAT ( " HOW MANY LEVELS OF B? ")
      READ(1,*)  Q
      WRITE(1,4403)
4403  FORMAT ( " HOW MANY LEVELS OF SS/CELL? ")
      READ(1,*)  N
      WRITE(1,757)
757   FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA , 0 IF NOT")
      READ(1,*) IPTO
      WRITE(1,987)
987   FORMAT("ENTER 1 FOR CRT PRINTOUT, OR 6 FOR LPTR")
      READ(1,*) IUNIT
      IF(IPTO.EQ.1) WRITE(IUNIT,109)
109   FORMAT(//,5X,"Y",10X,"X",//)
      XN=N
```

```
      DO 240 I=1,P
      DO 330 J=1,Q
      DO 440 K=1,N
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) Y,X
      IF (IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
      SX=SX+X
      JJ=(I-1)*Q+J
      SUMX(JJ)=SUMX(JJ)+Y
      SUMX2(JJ)=SUMX2(JJ)+Y*Y
      SY=SY+Y
      ZS=ZS+X*Y
      YS=YS+Y*Y
      XS=XS+X*X
      SA=SA+X
      AS=AS+Y
      SN=SN+X
      SNS=SNS+Y
      BXX(J)=BXX(J)+X
440   BYY(J)=BYY(J)+Y
      IF (IPTO.EQ.1) WRITE(IUNIT,33)
33    FORMAT(//)
      BA=BA+SNS*SNS/XN
      AB=AB+SN*SN/XN
      ZZ=ZZ+SNS*SN/XN
      SNSN=SNS/XN
      SNN=SN/XN
      SN=0
330   SNS=0
      QN=Q*N
      AX=AX+SA*SA/QN
      AY=AY+AS*AS/QN
      AZ=AZ+SA*AS/QN
      ASQN=AS/QN
      SAQN=SA/QN
      SA=0
240   AS=0
      PQN=P*Q*N
      SZ=SY*SX/PQN
      SY=SY*SY/PQN
      SX=SX*SX/PQN
      DO 620 J=1,Q
      PN=P*N
      BY=BY+BYY(J)*BYY(J)/PN
      BX=BX+BXX(J)*BXX(J)/PN
      BZ=BZ+BXX(J)*BYY(J)/PN
      BYJPN=BYY(J)/PN
      BXJPN=BXX(J)/PN
620   CONTINUE
      WRITE(IUNIT,171)AY,BY,BA,YS,SY
171   FORMAT(//,1X,"Y-TERMS (DEPENDENT VARIABLE)",
     X/," (A)   ",F13.4,5X,"  (B)",F13.4,5X,"  (AB)",F13.4,
     X/," (ABS)",F13.4,5X,"  (Y)",F13.4,/)
```

```
      WRITE(IUNIT,177)AX,BX,AB,XS,SX
177   FORMAT(1X,"X-TERMS (COVARIABLE)",
     X/," (A)  ",F13.4,5X,"  (B)",F13.4,5X,"  (AB)",F13.4,
     X/," (ABS)",F13.4,5X,"  (X)",F13.4,/)
      WRITE(IUNIT,183)AZ,BZ,ZZ,ZS,SZ
183   FORMAT(1X,"XY-TERMS",
     X/," (A)  ",F13.4,5X,"  (B)",F13.4,6X," (AB)",F13.4,
     X/," (ABS)",F13.4,5X," (XY)",F13.4,/)
      WRITE(IUNIT,701)
701   FORMAT(////,"0  CELL",4X,"N",7X,"SUMX",6X,"SUMX2",9X,"MEAN",
     110X,"SD",/)
      DO 704 I=1,P
      DO 704 J=1,Q
      JJ=(I-1)*Q+J
      XB1=SUMX(JJ)/XN
      SD1=DSQRT((SUMX2(JJ)-(SUMX(JJ)*SUMX(JJ))/XN)/(XN-1.))
704   WRITE(IUNIT,705) I,J,N,SUMX(JJ),SUMX2(JJ),XB1,SD1
705   FORMAT(1X,2I2,3X,I3,4(3X,F10.3))
      SA=(AZ-SZ)/DSQRT((AY-SY)*(AX-SX))
      AS=(BZ-SZ)/DSQRT((BY-SY)*(BX-SX))
      X=(ZS-SZ)/DSQRT((YS-SY)*(XS-SX))
      SH=(ZZ+SZ-AZ-BZ)/DSQRT((BA+SY-AY-BY)*(AB+SX-AX-BX))
      SHS=(ZS-ZZ)/DSQRT((YS-BA)*(XS-AB))
      Y=(EZ-AZ)/DSQRT((EY-AY)*(EX-AX))
      C=SY
      DD=SX
      ZI=SZ
      SY=YS-BA
      SX=XS-AB
      SZ=ZS-ZZ
      BA=BA+C-AY-BY
      AB=AB+DD-AX-BX
      ZZ=ZZ+ZI-AZ-BZ
      AY=AY-C
      AX=AX-DD
      AZ=AZ-ZI
      BY=BY-C
      BX=BX-DD
      BZ=BZ-ZI
      YS=YS-C
      XS=XS-DD
      ZS=ZS-ZI
      C=SY-SZ*SZ/SX
      AX=(AY+SY)-(AZ+SZ)*(AZ+SZ)/(AX+SX)-C
      BX=(BY+SY)-(BZ+SZ)*(BZ+SZ)/(BX+SX)-C
      AB=(BA+SY)-(ZZ+SZ)*(ZZ+SZ)/(AB+SX)-C
      XS=YS-ZS*ZS/XS
      J=N*P*Q-2
      D=P*Q*(N-1)-1
      P=P-1
      Q=Q-1
      I=P*Q
      AY=AX/P
```

```
      BY=BX/Q
      BA=AB/I
      SX=C/D
      WRITE(IUNIT,545)
545   FORMAT(/,"                         SOURCE TABLE",/)
      WRITE(IUNIT,550)
550   FORMAT(1X,"SOURCE",6X,"SS",10X,"DF",12X,"MS",12X,"F",11X,
     C"P(F)")
      AYSX=AY/SX
      DF1=P
      DF2=D
      F=AYSX
      CALL FPROB(F,DF1,DF2,Z,PF1)
      WRITE(IUNIT,555)AX,P,AY,AYSX,PF1
555   FORMAT(//," A",5X,F13.3,5X,I3,5X,F13.3,3X,F11.5,3X,F10.5)
      BYSX=BY/SX
      DF1=Q
      F=BYSX
      CALL FPROB(F,DF1,DF2,Z,PF2)
      WRITE(IUNIT,556)BX,Q,BY,BYSX,PF2
556   FORMAT(" B",5X,F13.3,5X,I3,5X,F13.3,3X,F11.5,3X,F10.5)
      BASX=BA/SX
      F=BASX
      TI=I
      CALL FPROB(F,TI,DF2,ZF3,PF3)
      WRITE(IUNIT,560)AB,I,BA,BASX,PF3
560   FORMAT(" AB",4X,F13.3,5X,I3,5X,F13.3,3X,F11.5,3X,F10.5)
      WRITE(IUNIT,561)C,D,SX
561   FORMAT(1X,"ERROR ",F13.3,5X,I3,5X,F13.3,/)
      WRITE(IUNIT,565)XS,J
565   FORMAT(1X,"TOTAL ",F13.3,5X,I3,///)
      WRITE(IUNIT,811)
811   FORMAT(1X,"CORRELATION COEFFICIENTS",/)
      WRITE(IUNIT,812)SA,AS
812   FORMAT(1X,"A     ",F11.3,/,1X,"B     ",F11.3)
      WRITE(IUNIT,820)SN,SNS
820   FORMAT(1X,"AB    ",F11.3,/,1X,"ERROR",F11.3)
      WRITE(IUNIT,821)X
821   FORMAT(1X,"TOTAL",F11.3)
      CALL CLOSE(IB)
      STOP
      END
      END$
```

AC21B (SPFAC-P.Q) (Two-way Split Plot Analysis of Covariance, One Repeated Measure)

Purpose:

This program performs a two-way split-plot analysis of covariance for one covariate.

Mathematical Model:

The model for this design is:

$$Y_{ijm(adj)} = Y_{ijm} - B'_b(\overline{X}_{ij.} - \overline{X}...) - B'_w(X_{ijm} - \overline{X}...) = u +$$

$$A_i - B_j + AB_{ij} + \Sigma_{m(i)} + B\Sigma_{jm(i)} + E_{ijm}$$

where:

Y_{ij} = unadjusted criterion measure

B'_b = between subject variation

B'_w = within subject variation

X_{ij} = covariate measure for subject i in the treatment population j

The hypotheses to be tested are:

Ho: A_i = 0 for all i

Ho: B_j = 0 for all j

Ho: AB_{ij} = 0 for all ij

Layout of Design:

	B_1		B_2		B_3	
	Y	X	Y	X	Y	X
A_1	S_1		S_1		S_1	
A_2	S_2		S_2		S_2	

1. There are two Factors (A and B) with p,q levels of treatments, respectively. Factor A is disignated as the between block or nonrepeated measure. Factor B is the within block or repeated measure. The above example includes two levels of Factor A, three levels of Factor B.

2. Subjects from a common population are randomly assigned to the levels of Factor A. After this, levels of treatment B are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.

3. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.

4. The relationship of the dependent variable and the covariate is linear.

5. For repeated measures, the dependent measure for each subject is paired with a unique covariate measure. The covariate cannot be identical for all measures, e.g., age of the subject.

User Considerations and Procedures:

1. A data file must be created sequentially with two variables per record - the dependent variable (Y) first, then the covariate (X). On read input, vary the subject fastest, then B, and finally A. (For example, record one contains subject one for treatment and covariate of ab_{11}, record two is subject two, ab_{11}; continue for all subjects in treatment ab_{11}. Next, enter all subjects for treatment ab_{12}; repeat for ab_{1q}. Then enter data for ab_{21} . . .; the final record would be subject ab_{pq}.) A printout of raw data would show two data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of Factor A (see comments)

   b. number of levels of Factor B (see comments)

c. number of subjects per level of Factor A (maximum 100)

d. name of data file

e. format of data file

5. Printout gives:

a. raw data by group (optional)

b. for each group: N, Σy, Σy^2, $\overline{Y}$, SD

c. ANOVA source table

d. intermediate calculations of the adjusted scores

e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependent variable. With analysis of covariance the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on the printout of the data must be used to adjust the means. Computational procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 482-485.

This program has the following restrictions:

1. The number of subjects for each level of A should be equal.

2. There cannot be more than 1,000 treatment combinations ($p*q \leq 1000$).

Test Data

This program was tested by comparing the results of the AC21B program to results obtained from a similar PDP 8/e Analysis of Covariance program. The program uses double precision in all calculations.

```
 RU,AC21B
AC21B OR
SPFAC-P,Q   ANALYSIS OF COVARIANCE TWO FACTORS MIXED
            DESIGN:  REPEATED MEASURES ON FACTOR B.  ON INPUT INDEX
            FOR SUBJECTS FIRST, THEN FOR WITHIN FACTOR B, THEN
            BETWEEN FACTOR A.  ENTER TWO POINTS PER LINE - DEPENDENT
            VARIABLE AND THEN THE COVARIATE
ENTER DATA FILE NAME
#JSPFA
ENTER DATA FORMAT
(2(2X,F8.4))
 ENTER THE RECORD LENGTH AS IN DA3Ø
2Ø
ENTER 1 FOR CRT DISPLAY, 6 FOR PRINTER
6
ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER Ø
1
 HOW MANY LEVELS OF A?
3
 HOW MANY LEVELS OF B?
2
 SS/LEVEL OF A?
3
  AC21B  :  STOP    ØØØØ
:
```

Y	X
8.0000	3.0000
11.0000	5.0000
16.0000	11.0000
14.0000	4.0000
18.0000	9.0000
22.0000	14.0000
6.0000	2.0000
12.0000	8.0000
9.0000	10.0000
8.0000	1.0000
14.0000	9.0000
10.0000	9.0000
10.0000	7.0000
14.0000	8.0000
15.0000	9.0000
10.0000	4.0000
18.0000	10.0000
22.0000	12.0000

Y-TERMS (DEPENDENT VARIABLE)

(A)	3220.5000	(B)	3188.5556	(AB)	3305.0000
(ABS)	3495.0000	(Y)	3120.5000	(AS)	3397.5000

X-TERMS (COVARIABLE)

(A)	1022.8333	(B)	1017.0000	(AB)	1034.3333
(ABS)	1233.0000	(X)	1012.5000	(AS)	1207.5000

XY-TERMS

(A)	1807.5000	(B)	1795.0000	(AB)	1835.6667
(ABS)	2004.0000	(XY)	1777.5000	(AS)	1964.0000

CELL		N	SUMX	SUMX2	MEAN	SD
1	1	3	35.000	441.000	11.667	4.041
1	2	3	54.000	1004.000	18.000	4.000
2	1	3	27.000	261.000	9.000	3.000
2	2	3	32.000	360.000	10.667	3.055
3	1	3	39.000	521.000	13.000	2.646
3	2	3	50.000	908.000	16.667	6.110

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	54.259	2.000	27.129	3.057	.136
ERRCR	44.370	5.000	8.874		
B	31.547	1.000	31.547	52.613	.001
AB	2.339	2.000	1.170	1.951	.236
ERROR	2.998	5.000	.600		
TOTAL	141.837	15.			

CORRELATION COEFFICIENTS

A	.933
ERROR	.866
B	1.000
AB	.994
ERROR	.877
TOTAL	.788

```
"AC21B T=00004 IS ON CR00002 USING 00030 BLKS R=0238

FTN4
           PROGRAM AC21B
           INTEGER P,Q,D
           DOUBLE PRECISION BXX(100),BYY(100),EXX(100),EYY(100)
           DIMENSION IB(272),IBUF(256),NFILE(3),IFMT(20)
           DOUBLE PRECISION SUMX(1000),SUMX2(1000)
           DOUBLE PRECISION X,Y,SX,SY,ZS,YS,XS,SA,AS,SN,SSN,BA,AB,ZZ,AX,
          CAY,
          1AZ,ASQN,SAQN,EX,EY,EZ,SZ,BY,BZ,BX,BXPN,BYPN,C,DD,Z1,SK,D,AYBZ,
          1BYSX,BASX,PQN,PN,XN,QZ,FN
           DO 1054 I=1,100
           BXX(I)=0.
           BYY(I)=0.
           EXX(I)=0.
     1054  EYY(I)=0.
           WRITE(1,3999)
     3999  FORMAT("AC21B OR ",/,
          C"SPFAC-P.Q   ANALYSIS OF COVARIANCE  TWO FACTORS MIXED",/
          #,12X,"DESIGN : REPEATED MEASURES ON FACTOR B.  ON INPUT INDEX",
          $/,12X,"FOR SUBJECTS FIRST, THEN FOR WITHIN FACTOR B , THEN ",/,
          %12X,"BETWEEN FACTOR A. ENTER TWO POINTS PER LINE - DEPENDENT",
          %/,12X,"VARIABLE AND THEN THE COVARIATE",/,
          C"ENTER DATA FILE NAME ")
           READ(1,87) NFILE
     87    FORMAT(3A2)
           WRITE(1,99)
     99    FORMAT("ENTER DATA FORMAT ")
           READ(1,123) IFMT
     123   FORMAT(20A2)
           IDCBS=256
           CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
           IF (IER.GE.0) GO TO 546
           WRITE(1,430) NFILE,IER
     430   FORMAT(3A2,"  FAILED TO OPEN, IER = ",I5)
           STOP 430
     546   WRITE(1,209)
     209   FORMAT("ENTER 1 FOR CRT DISPLAY, 6 FOR PRINTER")
           READ(1,*) IUNIT
           WRITE(1,219)
     219   FORMAT("ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0")
           READ(1,*) IPTO
           WRITE(1,4401)
     4401  FORMAT ( " HOW MANY LEVELS OF A? ")
           READ(1,*)  P
           WRITE(1,4402)
     4402  FORMAT ( "HOW MANY LEVELS OF B?  ")
           READ(1,*) Q
           WRITE(1,4403)
```

```
4403  FORMAT ( " SS/LEVEL OF A?  ")
      READ(1,*) N
      XN=N
      PQN=P*Q*N
      QN=Q*N
      DO 250 I=1,P
      DO 330 J=1,Q
      IF(IPTO.EQ.1) WRITE(IUNIT,923)
923   FORMAT(/)
      DO 440 K=1,N
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) Y,X
      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
      SX=SX+X
      II=(I-1)*Q+J
      SUMX(II)=SUMX(II)+Y
      SUMX2(II)=SUMX2(II)+Y*Y
      SY=SY+Y
      ZS=ZS+X*Y
      YS=YS+Y*Y
      XS=XS+X*X
      SA=SA+X
      AS=AS+Y
      SN=SN+X
      SSN=SSN+Y
      BXX(J)=BXX(J)+X
      BYY(J)=BYY(J)+Y
      EXX(K)=EXX(K)+X
440   EYY(K)=EYY(K)+Y
      BA=BA+SSN*SSN/XN
      AB=AB+SN*SN/XN
      ZZ=ZZ+SSN*SN/XN
      SNSN=SSN/XN
      SNN=SN/XN
      SN=0
330   SSN=0
      AX=AX+SA*SA/QN
      AY=AY+AS*AS/QN
      AZ=AZ+SA*AS/QN
      ASQN=AS/QN
      SAQN=SA/QN
      QZ=Q
      PN=P*N
      DO 720 K=1,N
      EX=EX+EXX(K)*EXX(K)/QZ
      EY=EY+EYY(K)*EYY(K)/QZ
      EZ=EZ+EXX(K)*EYY(K)/QZ
      EXX(K)=0
720   EYY(K)=0
      SA=0
250   AS=0
      SZ=SY*SX/PQN
      SY=SY*SY/PQN
      SX=SX*SX/PQN
      DO 620 J=1,Q
```

```
      BY=BY+BYY(J)*BYY(J)/PN
      BX=BX+BXX(J)*BXX(J)/PN
      BZ=BZ+BXX(J)*BYY(J)/PN
      BYPN=BYY(J)/PN
      BXPN=BXX(J)/PN
620   CONTINUE
      WRITE(IUNIT,170)
170   FORMAT(/,1X," Y-TERMS (DEPENDENT VARIABLE)",/)
      WRITE(IUNIT,171)AY,BY,BA
171   FORMAT(1X,"  (A)",F9.4,5X,"  (B)",F9.4,4X,"  (AB)",F9.4)
      WRITE(IUNIT,175)YS,SY,EY
175   FORMAT(1X,"(ABS)",F9.4,5X,"  (Y)",F9.4,4X,"  (AS)",F9.4)
      WRITE(IUNIT,177)
177   FORMAT(1X,/," X-TERMS (COVARIABLE)",/)
      WRITE(IUNIT,180)AX,BX,AB
180   FORMAT(1X,"  (A)",F9.4,5X,"  (B)",F9.4,5X," (AB)",F9.4)
      WRITE(IUNIT,181)XS,SX,EX
181   FORMAT(1X,"(ABS)",F9.4,5X,"  (X)",F9.4,5X," (AS)",F9.4)
      WRITE(IUNIT,185)
185   FORMAT(1X," XY-TERMS",/)
      WRITE(IUNIT,186)AZ,BZ,ZZ
186   FORMAT(1X,"  (A)",F9.4,5X,"  (B)",F9.4,5X," (AB)",F9.4)
      WRITE(IUNIT,190)ZS,SZ,EZ
190   FORMAT(1X,"(ABS)",F9.4,5X," (XY)",F9.4,5X," (AS)",F9.4)
      WRITE(IUNIT,1270)
1270  FORMAT(////,"0  CELL",4X,"N",7X,"SUMX",6X,"SUMX2",9X,"MEAN",
     110X,"SD",/)
      DO 700 I=1,P
      DO 700 J=1,Q
      II=(I-1)*Q+J
      XB1=SUMX(II)/XN
      SD1=DSQRT((SUMX2(II)-(SUMX(II)*SUMX(II))/XN)/(XN-1.))
      WRITE(IUNIT,956) I,J,N,SUMX(II),SUMX2(II),XB1,SD1
956   FORMAT(1X,2I3,2X,I3,4(3X,F10.3))
700   CONTINUE
      SA=(AZ-SZ)/DSQRT((AY-SY)*(AX-SX))
      AS=(BZ-SZ)/DSQRT((BY-SY)*(BX-SX))
      X=(ZS-SZ)/DSQRT((YS-SY)*(XS-SX))
      SN=(ZZ+SZ-AZ-BZ)/DSQRT((BA+SY-AY-BY)*(AB+SX-AX-BX))
      SSN=(ZS+AZ-ZZ-EZ)/DSQRT((YS+AY-BA-EY)*(XS+AX-AB-EX))
      Y=(EZ-AZ)/DSQRT((EY-AY)*(EX-AX))
      C=SY
      DD=SX
      ZI=SZ
      SY=YS+AY-BA-EY
      SX=XS+AX-AB-EX
      SZ=ZS+AZ-ZZ-EZ
      EY=EY-AY
      EX=EX-AX
      EZ=EZ-AZ
      ZK=EY-EZ*EZ/EX
      BA=BA+C-AY-BY
      AB=AB+DD-AX-BX
      ZZ=ZZ+ZI-AZ-BZ
```

```
      AY=AY-C
      AX=AX-DD
      AZ=AZ-ZI
      BY=BY-C
      BX=BX-DD
      BZ=BZ-ZI
      YS=YS-C
      XS=XS-DD
      ZS=ZS-ZI
      C=SY-SZ*SZ/SX
      AX=(AY+EY)-(AZ+EZ)*(AZ+EZ)/(AX+EX)-ZK
      BX=(BY+SY)-(BZ+SZ)*(BZ+SZ)/(BX+SX)-C
      AZ=ZK
      K=P*(N-1)-1
      BZ=AZ/K
      AB=(BA+SY)-(ZZ+SZ)*(ZZ+SZ)/(AB+SX)-C
      XS=YS-ZS*ZS/XS
      J=K*P*Q-3
      D=P*(Q-1)*(N-1)-1
      P=P-1
      Q=Q-1
      I=P*Q
      AY=AX/P
      BY=BX/Q
      BA=AB/I
      SX=C/D
      WRITE(IUNIT,545)
545   FORMAT(12X,///,"                        SOURCE TABLE",//)
      WRITE(IUNIT,550)
550   FORMAT(" SOURCE",5X,"SS",13X,"DF",7X,"MS",18X,"F",11X,"P(F)")
      AYBZ=AY/BZ
      TP=P
      TK=K
      F=AYBZ
      CALL FPROB(F,TP,TK,Z1,PF1)
      WRITE(IUNIT,555)AX,P,AY,AYBZ,PF1
555   FORMAT(1X,"A      ",3X,F7.3,5X,F7.3,5X,F7.3,8X,F7.3,8X,F7.3)
      WRITE(IUNIT,571)AZ,K,BZ
571   FORMAT(1X,"ERROR ",3X,F7.3,5X,F7.3,5X,F7.3)
      BYSX=BY/SX
      F=BYSX
      DF1=Q
      DF2=D
      CALL FPROB(F,DF1,DF2,Z2,PF2)
      WRITE(IUNIT,556)BX,Q,BY,BYSX,PF2
556   FORMAT(1X,"B      ",3X,F7.3,5X,F7.3,5X,F7.3,8X,F7.3,8X,F7.3)
      BASX=BA/SX
      F=BASX
      DF1=I
      CALL FPROB(F,DF1,DF2,Z3,PF3)
      WRITE(IUNIT,560)AB,I,BA,BASX,PF3
560   FORMAT(1X,"AB     ",3X,F7.3,5X,F7.3,5X,F7.3,8X,F7.3,8X,F7.3)
      WRITE(IUNIT,561)C,D,SX
561   FORMAT(1X,"ERROR ",3X,F7.3,5X,F7.3,5X,F7.3,/)
      WRITE(IUNIT,565)XS,J
```

```
565   FORMAT(1X,"TOTAL ",3X,F7.3,8X,I3,/)
      WRITE(IUNIT,810)SA,Y
810   FORMAT(1X,"CORRELATION COEFFICIENTS",/," A     ",4X,F5.3,/," ERR
     XOR",4X,F5.3)
      WRITE(IUNIT,820)AS,SN,SSN
820   FORMAT(1X,"B     ",4X,F5.3,/," AB    ",4X,F5.3,/," ERROR",4X,
     CF5.3,/)
      WRITE(IUNIT,999)X
999   FORMAT(" TOTAL",4X,F5.3)
      CALL CLOSE(I8)
      STOP
      END
      END$
```

C. Multivariate Analysis of Variance

MAV10 (Multivariate One-way ANOVA)

Purpose:

This program performs a multivariate one-way analysis of variance.

Mathematical Model:

The model for this design is:

$$X_{ij(r)} = u_{(k)} + B_{j(r)} + E_{ij(r)}$$

The hypothesis to be tested is:

$$Ho: B_{jr} = 0 \text{ for all } jr$$

Layout of Design:

1. Same as AV10 except each treatment has multiple dependent variables.

2. Each subject has r responses.

3. There are k levels of treatments.

4. Subjects are randomly assigned to the treatment levels with each subject designated to receive only one level.

5. Under each treatment, there are an equal number of (NR) observations.

User Considerations and Procedures:

1. A matrix data file must be created with r data points per line. On input, index observations under each treatment fastest, then treatment. (For example, the first record contains r responses for subject one, treatment b_1; second record contains r responses for subject two, treatment b_1. . .. then r responses for subject one, treatment b_2. . ., last record contains responses for subject n treatment b_k). A printout of raw data would show r data points per line.

2. The data analysis can either be displayed on the CRT or a hard copy can be obtained from the line printer. Option. 1 for CRT output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. A printout of the sums of squares and cross products matrix (error matrix) can be obtained. Option: 1 if printout desired, 0 for no printout.

5. Parameters required:

   a. number of treatments (maximum 20)

   b. number of responses per subject (maximum 30)

   c. number of subjects per treatment level (maximum 30)

   d. name of data file

   e. format of data file

6. Printout gives:

   a. raw data (optional)

   b. error matrix (optional)

   c. the U-statistic with degrees of freedom

   d. approximate F-value, degrees of freedom, and approximate alpha level

Test Data:

This program was tested using data from Clyde Kramer's, A First Course in Multivariate Analysis, Clyde Kramer, Publisher, 1972, Pp. 121-144.

```
RU, MAV10
 SU,4
      ONE-WAY MANOVA WITH NO RANDOMIZED BLOCKS

ENTER NAME OF YOUR DATA FILE
OMAV10
ENTER DATA FORMAT
(F4.1,1X,F3.1)
ENTER NUMBER OF TREATMENTS AND NUMBER OF VARIABLES
4,2
ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0
1
ENTER 1 FOR CRT, 6 FOR LINEPRINTER
1
ENTER NUMBER OF OBSERVATIONS FOR TREATMENT        1
7
24.03.5
13.33.5
12.24.0
14.04.0
22.23.6
16.14.3
27.95.2
ENTER NUMBER OF OBSERVATIONS FOR TREATMENT        2
7
 7.43.5
13.23.0
 8.53.0
10.13.0
 9.32.0
 8.32.5
 4.31.5
ENTER NUMBER OF OBSERVATIONS FOR TREATMENT        3
5
16.43.2
24.02.5
53.01.5
32.72.6
42.82.0
ENTER NUMBER OF OBSERVATIONS FOR TREATMENT        4
2
25.12.7
 5.92.3
ENTER 1 FOR PRINTOUT OF ERROR MATRIX
1
          THE ERROR SS AND CP MATRIX
```

```
ROW    1
 .13026794285D+04        -.17644000001D+02
ROW    2
-.17644000000D+02         .67777142865D+01
THE U-STATISTIC EQUALS        .15961411397D+00
WITH DEGREES OF FREEDOM           2       3       20
THE APPROXIMATE F-VALUE, DEGREES OF FREEDOM
     9.51913       6      38
AND THE ALPHA LEVEL IS        .0000195
MAV02 ABORTED
:
```

```
MAV10   T=00003 IS ON CR00002 USING 00001 BLKS R=0000

:SV,4
:RP,MAV02
:RU,MAV01
:OF,MAV02
:SV,0
```

```
*MAV01 T=00003 IS ON CR00002 USING 00013 BLKS R=0000

FTN4,L
        PROGRAM MAV01
        DOUBLE PRECISION Y(30),T(20,30),G(30),H(30,30),E(30,30),
       1SUM,TN,SU,DET,DETH,T4,DF1,DF2
        INTEGER R
        COMMON I,J,R,H,E,DET,DETH,IUNIT,TN,T,G,Y,N(30),NAME(3),IFMT(20)
        COMMON IB(272),IBUF(256)
        DIMENSION NM(3)
        DATA NM/2HMA,2HVO,1H2/
        WRITE(1,1)
 1      FORMAT(5X,"ONE-WAY MANOVA WITH NO RANDOMIZED BLOCKS",/)
        WRITE(1,2)
 2      FORMAT("ENTER NAME OF YOUR DATA FILE")
        READ(1,3) NAME
 3      FORMAT(3A2)
        WRITE(1,4)
 4      FORMAT("ENTER DATA FORMAT")
        READ(1,5) IFMT
 5      FORMAT(20A2)
        CALL OPEN(IB,IER,NAME,3,0,0,256)
        IF(IER.GE.0) GO TO 10
        WRITE(1,6) NAME,IER
 6      FORMAT(3A2,"  FAILED TO OPEN, IER = ",I5)
        STOP
 10     WRITE(1,11)
 11     FORMAT("ENTER NUMBER OF TREATMENTS AND NUMBER OF VARIABLES")
        READ(1,*) J,R
 C      INTIALIZE ALL SS AND SCP AND SUMS
        NT=0
        DO 20 I=1,J
        DO 20 K=1,R
 20     T(I,K)=0.0D0
        DO 30 I=1,R
        G(I)=0.D0
        DO 30 K=1,R
        E(I,K)=0.D0
 30     H(I,K)=0.0D0
        WRITE(1,40)
 40     FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0")
        READ(1,*) IPTO
        WRITE(1,41)
 41     FORMAT("ENTER 1 FOR CRT, 6 FOR LINEPRINTER")
        READ(1,*) IUNIT
        DO 50 I=1,J
        WRITE(1,51) I
 51     FORMAT("ENTER NUMBER OF OBSERVATIONS FOR TREATMENT",I5)
        READ(1,*) N(I)
        TN=TN+N(I)
        IF((IPTO.EQ.1).AND.(IUNIT.EQ.6)) WRITE(6,52) I
 52     FORMAT(//,10X,"TREATMENT ",I5,/)
        DO 50 IV=1,N(I)
```

```
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (Y(K),K=1,R)
      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT)(Y(K),K=1,R)
      DO 53 K=1,R
      T(I,K)=T(I,K)+Y(K)
      G(K)=G(K)+Y(K)
53    CONTINUE
50    CONTINUE
      CALL RWNDF(IB)
C     CALCULATE H MATRIX
      DO 200 I=1,R
      DO 200 L=1,R
      SUM=0.D0
      DO 210 K=1,J
210   SUM=SUM+T(K,L)*T(K,I)/N(K)
      E(I,L)=-SUM
200   H(I,L)=SUM-G(I)*G(L)/TN
C     CAL.   E MATRIX
      DO 300 I=1,R
      DO 300 L=1,R
      SU=0.D0
      DO 320 M=1,J
      DO 320 N1=1,N(M)
      CALL READF(IB,IR,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(Y(IK),IK=1,R)
      SU=SU+Y(I)*Y(L)
320   CONTINUE
      CALL RWNDF(IB)
300   E(I,L)=E(I,L)+SU
      WRITE(1,157)
157   FORMAT("ENTER 1 FOR PRINTOUT OF ERROR MATRIX")
      READ(1,*) IPTO
      IF(IPTO.NE.1) GO TO 507
C     WRITE OUT E MATRIX
      WRITE(IUNIT,500)
500   FORMAT(//10X,"THE ERROR SS AND CP MATRIX",/)
      DO 501 I=1,R
      WRITE(IUNIT,503) I
503   FORMAT(/,5X,"ROW",I5)
 501  WRITE(IUNIT,502) (E(I,K),K=1,R)
502   FORMAT(5(5X,D17.11))
C     CREAT H+E MATQRIX    .... H
507   DO 600 I=1,R
      DO 600 K=1,R
600   H(I,K)=H(I,K)+E(I,K)
      CALL CLOSE(IB)
      CALL EXEC(9,NM)
      END
      END$
```

```
*MAV02 T=00003 IS ON CR00002 USING 00006 BLKS R=0000

FTN4,L
      PROGRAM MAV02
      INTEGER R
      DOUBLE PRECISION H(30,30),E(30,30),DET,DETH,SU,SUM,T4,DF1,DF2
      DOUBLE PRECISION TN
      COMMON I,J,R,H,E,DET,DETH,IUNIT,TN
      CALL MINV(H,R,DETH)
      CALL MINV(E,R,DET)
      DET=DET/DETH
      I1=J-1
      I2=TN-1
      I3=TN-2
      WRITE(IUNIT,800) DET
800   FORMAT(//,5X,"THE U-STATISTIC EQUALS",5X,D16.11)
      WRITE(IUNIT,802) R,I1,I2
802   FORMAT(/,5X,"WITH DEGREES OF FREEDOM    ",3(I7))
C     FIND APPROX. F LEVEL
      IF(R.NE.2) GO TO 900
      DETH=(1-DSQRT(DET))/DSQRT(DET)
      D=DETH*I3/I1
      E1=2*I1
      DE=2*(I2-1)
      GO TO 901
900   SUM=R*R+(J-1)*(J-1)
      SU=1
      IF(SUM.LE.5.0D0) GO TO 801
      SU=DSQRT((R*R*(J-1)*(J-1)-4.)/(SUM-5.))
801   T4=TN-1-(J+R)/2.
      DETH=DET**(1./SU)
      DF1=R*(J-1)
      DF2=1+T4*SU-R*(J-1)/2.
      DETH=((1.-DETH)/DETH)*DF1/DF2
C     USE SINGLE PREICSION IN CALL TO FPROB
      D=DETH
      E1=DF1
      DE=DF2
901   CALL FPROB(D,E1,DE,SD,FPR)
      WRITE(IUNIT,902) D,E1,DE,FPR
902   FORMAT(//," THE APPROXIMATE F-VALUE, DEGREES OF FREEDOM "
     &,/," = ",5X,F10.5,2(I7),/," AND THE ALPHA LEVEL IS",
     %5X,F10.7)
      END
      END$
```

MAV11 (Multivariate Two-way ANOVA, Repeated Measures)

Purpose:

This program performs a multivariate one-way analysis of variance with replication either using matched subjects or by repeated measures.

Mathematical Model:

The model for this analysis is:

$$X_{ij(r)} = \mu_{(r)} + \pi_{i(r)} + B_{j(r)} + E_{ij(r)}$$

The hypothesis to be tested is:

$$Ho: B_{jr} = 0 \text{ for all } jr$$

Layout of Design:

1. Same as AV11 except each treatment has multiple dependent variables

2. Each subject has r responses

3. There are k levels of treatment B

4. Subjects are assigned to a treatment so that variability within a treatment is less than the variability among treatments. Homogenity within treatments may be achieved by using a subject as his own control or by using subjects matched on the basis of a variable that correlates with the dependent variable

5. Under each treatment there are equal number (NR) observations

User Considerations and Procedures:

1. A matrix data file must be created with r responses per record. On input, index responses fastest, then subjects, and treatment slowest. (For example, first record contains r responses for subject one, treatment b_1; second record contains r responses for subject two, treatment b_1. . ., then r responses for subject one, treatment b_2. . ., the last record contains the r responses for subject N, treatment b_k.) A printout would show r data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. A printout of the sums of squares and cross product matrix (error matrix) can be obtained. Option: 1 if printout is desired, 0 for no printout.

5. Parameters required:

   a. number of subjects (maximum 20)

   b. number of treatments (maximum 20)

   c. number of responses per subject (maximum 30)

   d. name of data file

   e. format of data file

6. Printout gives:

   a. raw data (optional)

   b. error matrix (optional)

   c. block (subject) totals for each dependent variable

   d. treatment totals for each dependent variable

   e. the U-statistics with degrees of freedom

   f. approximate F-test with degrees of freedom and alpha level

Comments:

Mount a scratch tape before running program.

Test Data:

This program was tested from Clyde Kramer's, A First Course in Multivariate Analysis, Clyde Kramer, Publisher, 1972, Pp 145-158.

```
RU, MAV11
 SU,4
PROGRAM TO PERFORM ONE-WAY MANOVA WITH
REPEATED MEASURES (OR RANDOMIZED BLOCKS)

ENTER NAME OF DATA FILE
#MAV11
ENTER FORMAT OF FILE
(3(2X,F3.0))
ENTER NUMBER OF BLOCKS, TREATMENTS, AND VARIATES
4,5,3
ENTER 1 FOR LISTING OF RAW DATA, ELSE ENTER Ø
1
ENTER 1 FOR ERROR MATRIX PRINTOUT, ELSE ENTER Ø
1
ENTER 1 FOR CRT, OR 6 FOR LINE PRINTER OUTPUT
6

ENTER 1 FOR PRINTOUT OF TREATMENT AND BLOCK TOTALS
1
MAV1B ABORTED
MAV1C ABORTED
```

RAW DATA

TREATMENT 1

96.	10.	725
142.	16.	700
122.	13.	655
111.	13.	680

TREATMENT 2

102.	15.	695
106.	10.	710
95.	14.	705
93.	12.	680

TREATMENT 3

109.	15.	690
113.	15.	690
101.	14.	680
100.	19.	685

TREATMENT 4

103.	17.	680
97.	16.	690
99.	13.	730
135.	12.	670

TREATMENT 5

98.	17.	680
97.	14.	695
105.	16.	680
86.	22.	710

PRINTOUT OF BLOCK TOTALS

508.00000	74.00000	3470.00000
555.00000	71.00000	3485.00000
522.00000	70.00000	3450.00000
525.00000	78.00000	3425.0000

PRINTOUT OF TREATMENT TOTALS

471.00000	52.00000	2760.00000
396.00000	51.00000	2790.00000
423.00000	63.00000	2745.00000
434.00000	58.00000	2770.00000
386.00000	69.00000	2765.00000

THE ERROR SS AND CP MATRIX IS

.22589000001D+04	-.2464999998D+02	-.1658250000D+04
-.2464999998D+02	.91500000000D+02	.40000000000D+01
-.1658250000D+04	.40000000000D+01	.55325000000D+04

THE U-STATISTIC EQUALS .3990056930
WITH DESGREES OF FREEDOM 3 4 12

THE APPROXIMATE F VALUE, DEGREES OF FREEDOM,
= 1.20013 12 35
AND THE ALPHA LEVEL IS .3212206

```
MAV11   T-00004 IS ON CR00002 USING 00001 BLKS R=0009

:SV,4
:CN
:RP,MAV1B
:RP,MAV1C
:RU,MAV1A
:OF,MAV1B
:OF,MAV1C
:CN
:SV,0
:
```

```
*MAV1A T=00003 IS ON CR00002 USING 00008 BLKS R=0000

FTN4,L
      PROGRAM MAV1A
      DOUBLE PRECISION Z(30)
      INTEGER B,T,P
      COMMON B,T,P,IUNIT,IPT,IPT1,IFMT(20),IBUF(256),IB(272),Z
      DIMENSION NM(3),NAME(3)
      DATA NM/2HMA,2HV1,1HB/
      REWIND 8
      WRITE(1,1)
1     FORMAT("PROGRAM TO PERFORM ONE-WAY MANOVA WITH ",/,
     &"REPEATED MEASURES ( OR RANDOMIZED BLOCKS)",//)
      WRITE(1,2)
2     FORMAT("ENTER NAME OF DATA FILE")
      READ(1,3) NAME
3     FORMAT(3A2)
      WRITE(1,4)
4     FORMAT("ENTER FORMAT OF FILE")
      READ(1,5) IFMT
5     FORMAT(20A2)
      WRITE(1,6)
6     FORMAT("ENTER NUMBER OF BLOCKS,TREATMENTS, AND VARIATES")
      READ(1,*) B,T,P
      CALL OPEN(IB,IER,NAME,3,0,0,272)
      IF(IER.GE.0) GO TO 20
      WRITE(1,7) NAME,IER
7     FORMAT(3A2,5X,"FAILED TO OPEN, IER = ",I5)
      STOP 7777
20    WRITE(1,21)
21    FORMAT("ENTER 1 FOR LISTING OF RAW DATA, ELSE ENTER 0")
      READ(1,*) IPT0
      WRITE(1,22)
22    FORMAT("ENTER 1 FOR ERROR MATRIX PRINTOUT, ELSE ENTER 0")
      READ(1,*) IPT
      WRITE(1,23)
23    FORMAT("ENTER 1 FOR CRT, OR 6 FOR LINEPRONTER OUTPUT")
      READ(1,*) IUNIT
      IF(IPT0.EQ.1) WRITE(IUNIT,24)
24    FORMAT(//,5X,"RAW DATA",/)
      DO 30 I=1,T
      IF(IPT0.EQ.1) WRITE(IUNIT,25) I
25    FORMAT(/,10X,"TREATMENT ",I7)
      DO 30 J=1,B
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (Z(K),K=1,P)
      IF(IPT0.EQ.1) WRITE(IUNIT,IFMT) (Z(K),K=1,P)
30    WRITE(8,IFMT) (Z(K),K=1,P)
      ENDFILE 8
      REWIND 8
      CALL CLOSE(IB)
      WRITE(1,60)
60    FORMAT(//,"ENTER 1 FOR PRINTOUT OF TREATMENT AND BLOCK TOTALS")
      READ(1,*) IPT1
      CALL EXEC(9,NM)
      END
      END$
```

```
*MAV1B T=00003 IS ON CR00002 USING 00009 BLKS R=0000

FTN4,L
      PROGRAM MAV1B
      DOUBLE PRECISION B1(20,30),T1(20,30),G(30),H(30,30),E(30,30),
     &Y(30),BL,BK,TI,SUM
      INTEGER B,T,P
      COMMON B,T,P,IUNIT,IPT,ITP1,IFMT(20),H,E,B1,H1,G,Y
      DIMENSION NM(3)
      DATA NM/2HMA,2HV1,1HC/
      DO10 I=1,20
      DO10 J=1,30
      G(J)=0.D0
      B1(I,J)=0.D0
10    T1(I,J)=0.D0
      CALL ENDIO
      DO 30 I=1,T
      DO 30 J=1,B
      READ(8,IFMT) (Y(II),II=1,P)
      DO 30 K=1,P
      B1(J,K)=B1(J,K)+Y(K)
30    T1(I,K)=T1(I,K)+Y(K)
      REWIND 8
      DO 40 K=1,P
      DO 40 I=1,B
40    G(K)=G(K)+B1(I,K)
      BI=B
      BK=B*T
      TI=T
      IF(ITP1.NE.1) GO TO 41
      WRITE(IUNIT,42)
42    FORMAT(//,5X,"PRINTOUT OF BLOCK TOTALS",/)
      DO 44 I=1,B
      WRITE(IUNIT,43)
43    FORMAT(5X)
44    WRITE(IUNIT,45)(B1(I,K),K=1,P)
45    FORMAT(5(3X,F13.5))
      WRITE(IUNIT,46)
46    FORMAT(///,5X,"PRINTOUT OF TREATMENT TOTALS",/)
      DO 47 I=1,T
      WRITE(IUNIT,43)
47    WRITE(IUNIT,45) (T1(I,K),K=1,P)
41    CONTINUE
      DO 50 I=1,P
      DO 50 J=1,P
      SUM=0.D0
      DO 60 K=1,T
60    SUM=SUM+T1(K,I)*T1(K,J)
      H(I,J)=SUM/BI-G(I)*G(J)/BK
      E(I,J)=-H(I,J)
      SUM=0.D0
      DO 70 K=1,B
```

```
 70     SUM=SUM+B1(K,I)*B1(K,J)
        E(I,J)=E(I,J)-SUM/TI
        SUM=0.D0
        DO 90 I1=1,T
        DO 90 J1=1,B
        CALL ENDIO
        READ(8,IFMT) (Y(K),K=1,P)
 90     SUM=SUM+Y(I)*Y(J)
        E(I,J)=E(I,J)+SUM
        REWIND 8
 50     CONTINUE
 C      H,E MATRIX COMPLETE OPTION FOR PRINT OF E
        IF(IPT.EQ.0) GO TO 100
        WRITE(IUNIT,500)
 500    FORMAT(//,10X,"THE ERROR SS AND CP MATRIX IS ",/)
        DO501 I=1,P
        WRITE(IUNIT,43)
 501    WRITE(IUNIT,502) (E(I,J),J=1,P)
 502    FORMAT(4(4X,D16.11))
 C      CREAT H+E   STORE IN H
 100    DO600 I=1,P
        DO600 J=1,P
 600    H(I,J)=H(I,J)+E(I,J)
 C      FINISHED WITH THIS PART
        CALL EXEC(9,NM)
        END
        END$
```

```
"MAVIC T=00003 IS ON CR00002 USING 00007 BLKS R=0000

FTN4,L
        PROGRAM MAVIC
        DOUBLE PRECISION H(30,30),E(30,30),DET,DET1,U,F
        DOUBLE PRECISION SUM,SU,T4,DF1
        INTEGER B,T,P
        COMMON B,T,P,IUNIT,ITP,ITP1,IFMT(20),H,E
        CALL MINV(E,P,DET)
        CALL MINV(H,P,DET1)
        U=DET/DET1
C       THE U-STATISTIC WITH DF P,I1,I2
        I1=T-1
        I2=(B-1)*I1
        I3=B*T
C       I1=DEGREES OF FREEDOM FOR HYPOTH     I2=DF FOR ERROR
C       I3=TOTAL SAMPLE SIZE
        WRITE(IUNIT,100) U,P,I1,I2
100     FORMAT(///,5X,"THE U-STATISTIC EQUALS",5X,F15.10,/,
       $5X,"WITH DEGREES OF FREEDOM ",3(5X,I7))
C       NEXT TO CAL APPOX. F-VAULE
C       CHECK FOR EXACT F-VALUE
        IF(P.NE.2) GO TO 200
        DET=DSQRT(U)
        DET=(1-DET)/DET
        D=DET*(I2-1)/I1
C       D=EXACT F VALUE
        E1=I1*2
        DE=2*(I2-1)
C       CALL FPROB
        GO TO 300
200     SUM=P*P+I1*I1
        SU=1.D0
        IF(SUM.LE.5.D0) GO TO 210
        SU=DSQRT((P*P*I1*I1-4.D0)/(SUM-5.D0))
 210    T4=I3-1-(T+P)/2.D0
        DET1=U**(1.D0/SU)
        DF1=P*I1
        DET=1+T4*SU-DF1/2.D0
        U=((1.D0-DET1)/DET1)*(DET/DF1)
C       USE SINGLE PRECISION ON FPROB CAL
        D=U
        E1=DF1
        DE=DET
C       D,E1,DE === F-VALUE,DEGREES OF FREEDOM
C       FPR= ALPHA - LEVEL
300     CALL FPROB(D,E1,DE,SD,FPR)
        WRITE(IUNIT,902) D,E1,DE,FPR
902     FORMAT(//," THE APPROXIMATE F-VALUE, DEGREES OF FREEDOM,"
       &,/," = ",5X,F10.5,2(I7),/," AND THE ALPHA LEVEL IS",
       %5X,F10.7)
        END
        END$
```

MAV20 (Multivariate Two-way ANOVA)

Purpose:

This program performs a two-way multivariate completely randomized analysis of variance.

Mathematical Model:

The model for this analysis is:

$$X_{ijk(r)} = M_{(r)} + A_{i(r)} + B_{j(r)} + AB_{ij(r)} + E_{ijk(r)}$$

The hypotheses to be tested are:

Ho: $A_{ir} = 0$ for all ir

Ho: $B_{jr} = 0$ for all jr

Ho: $AB_{ijr} = 0$ for all ijr

Layout of Design:

1. Same design as AV20, except each Factor has multiple dependent variables

2. Each subject has r responses

3. There are two factors (A,B) with p and q levels of treatments

4. Subjects are randomly assigned to the pq treatment combinations, with each subject receiving only one combination

5. There are an equal number of observations for each AB cell

User Considerations and Procedures:

1. A matrix data file must be created with r responses per record. On input subjects vary fastest, then factor B, and finally A. (For example, first record contains r responses for subject one, treatment ab_{11}, second record contains r responses for subject two, treatment ab_{11}. . ., then r responses for subject one, treatment ab_{12}. . ., then r responses for subject one, treatment ab_{21}. . ., final record would be r responses for subject k for treatment ab_{pq}.) A printout of raw data would show r data points per line.

2. The data analysis can be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. The printout of the sums of squares and cross product matrix (error matrix) can be obtained. Option: 1 if desired, 0 for no printout.

5. Parameters required:

   a. number of levels of Factor A (maximum 20)

   b. number of levels of Factor B (maximum 20)

   c. number of subjects per AB cell (maximum 32767)

   d. number of responses (r)

   e. name of data file

   f. format of data file

6. Printout gives:

   a. raw data (optional)

   b. error matrix (optional)

   c. cell totals

   d. the U-statistics with degrees of freedom

Test Data:

Program was tested from Clyde Kramer's, A First Course in Multivariate Analysis, Clyde Kramer, Publisher, 1972, Pp. 164-187.

```
RU,MAV20
TWO WAY MULTIVARIATE ANALYSIS OF VARIANCE

ENTER NAME OF RAW DATA FILE
#MAV20
ENTER FORMAT OF DATA
(3X,F4.1,2X,F5.1,2X,F4.1)
ENTER NUMBER OF LEVELS OF FACTOR A, FACTOR B, NUMBER OF VARIATES, AND
NUMBER OF OBSERVATIONS PER A,B TREATMENT CELL
2,3,3,4
ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER
6
ENTER 1 FOR RAW DATA LISTING, ELSE ENTER Ø
1
ENTER 1 FOR PRINTOUT OF ERROP MATRIX, ELSE ENTER Ø
1
ENTER 1 FOR PRINTOUT OF FACTOR TOTALS
1
```

RAW DATA

TREATMENT PAIR 1 1

40.1	85.6	46.8
41.1	83.2	41.7
40.9	79.5	38.1
39.4	78.0	39.6

CELL TOTALS

.16150000000D+03 .32630000000D+03 .16620000000D+03

TREATMENT PAIR 1 2

63.0	102.4	44.8
61.9	100.3	39.4
61.6	101.3	39.9
64.0	106.2	50.0

CELL TOTALS

.25050000000D+03 .41020000000D+03 .17410000000D+03

TREATMENT PAIR 2 1

52.8	114.4	47.1
53.6	115.6	42.1
53.9	114.2	42.3
53.8	113.2	35.7

CELL TOTALS

.21410000000D+03 .45740000000D+03 .16720000000D+03

TREATMENT PAIR 2 2

68.6	129.8	42.7
70.7	131.0	47.1
69.1	135.8	45.2
73.3	147.6	49.2

CELL TOTALS

.28170000000D+03 .54420000000D+03 .18420000000D+03

TREATMENT PAIR 3 1

41.6	142.3	45.8
37.7	137.0	37.0
43.2	143.8	44.0
42.0	143.6	40.8

CELL TOTALS

.16450000000D+03 .56670000000D+03 .16760000000D+03

TREATMENT PAIR 3 2

62.8	164.4	44.4
56.6	156.0	45.3
63.3	161.3	46.3
60.9	161.4	42.2

CELL TOTALS

.24360000000D+03 .64310000000D+03 .17820000000D+03

ERROR MATRIX

ROW # 1		
.64497499943D+02	.10466500044D+03	.48837500215D+02
ROW # 2		
.10466500044D+03	.32391249943D+03	.15558500028D+03
ROW # 3		
.48837500215D+02	.15558500028D+03	.25961750042D+03

ROW TREATMENT TOTALS

ROW # 1		
.41200000000D+03	.73650000000D+03	.34030000000D+03
ROW # 2		
49580000000D+03	.10016000000D+04	.35140000000D+03
ROW # 3		
.40810000000D+03	.12098000000D+04	.34580000000D+03

COLUMN TREATMENT TOTALS

COLUMN 1		
.54010000000D+03	.13504000000D+04	.50100000000D+03
COLUMN 2		
.77580000000D+03	.15975000000D+04	.53650000000D+03

HYPOTHESIS TEST RESULTS

HYPOTHESIS OF	U-STATISTIC	DEGREES OF FREEDOM		
INTERACTION EFFECT	.47183408163D+00	3	2	18
FACTOR A EFFECT	.77473471183D-03	3	1	18
FACTOR B EFFECT	.23177578747D-01	3	2	18

```
*MAV20 T=00004 IS ON CR00002 USING 00029 BLKS R=0238

FTN4,L
      PROGRAM MAV20
      INTEGER C,R,P
      DOUBLE PRECISION RIJ(30,30),G(30),X(30),SUM(30),RN,RCN,CN,SU
      DOUBLE PRECISION E(30,30),DETE,DET1,DET2,DET3
      COMMON C,R,P,N,IPT,IUNIT,RIJ,IFMT(20),IB(272),IBUF(256),
     $NAME(3),X,SUM,E
      EQUIVALENCE (G,SUM)
      REWIND 8
      WRITE(1,1)
1     FORMAT("TWO WAY MULTIVARIATE ANALYSIS OF VARIANCE",/
     $/,"ENTER NAME OF RAW DATA FILE")
      READ(1,2) NAME
2     FORMAT(3A2)
      CALL OPEN(IB,IER,NAME,3,0,0,272)
      IF(IER.GE.0) GO TO 20
323   WRITE(1,3) NAME,IER
3     FORMAT(3A2,"  FAILED TO OPEN, IER = ",I5)
      STOP
20    WRITE(1,5)
5     FORMAT("ENTER FORMAT OF DATA")
      READ(1,6) IFMT
6     FORMAT(20A2)
      WRITE(1,7)
7     FORMAT("ENTER NUMBER OF LEVELS OF FACTOR A, FACTOR B,",
     $"NUMBER OF VARIATES, AND ",/,"NUMBER OF OBSERVATIONS PER ",
     %"A,B TREATMENT CELL ")
      READ(1,*) C,R,P,N
      WRITE(1,14)
14    FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER")
      READ(1,*) IUNIT
      WRITE(1,15)
15    FORMAT("ENTER 1 FOR RAW DATA LISTING, ELSE ENTER 0")
      READ(1,*) IPTO
      WRITE(1,16)
16    FORMAT("ENTER 1 FOR PRINTOUT OF ERROR MATRIX, ELSE ENTER 0")
      READ(1,*) IPT
      WRITE(1,17)
17    FORMAT("ENTER 1 FOR PRINTOUT OF FACTOR TOTALS")
      READ(1,*) IPT1
      IF(IPTO.EQ.1)  WRITE(IUNIT,13)
13    FORMAT(//,5X,"RAW DATA",/)
      CALL ENDIO
      DO 30 I=1,R
      DO 30 J=1,C
      DO 40 K=1,N
40    SUM(K)=0.D0
      IF(IPTO.EQ.1) WRITE(IUNIT,11) I,J
11    FORMAT(15X,"TREATMENT PAIR ",2I7)
      DO 50 K=1,N
```

```
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (X(I1),I1=1,P)
      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (X(I1),I1=1,P)
      DO 50 I1=1,P
50    SUM(I1)=SUM(I1)+X(I1)
      WRITE(8,51) (SUM(I1),I1=1,P)
51    FORMAT(30D16.11)
      IF(IPT1.NE.1) GO TO 30
      WRITE(IUNIT,123)
123   FORMAT(" CELL TOTALS")
      WRITE(IUNIT,522) (SUM(I1),I1=1,P)
      WRITE(IUNIT,533)
522   FORMAT(5X,4(3X,D16.11))
533   FORMAT(5X)
30    CONTINUE
      CALL RWNDF(IB)
C     NOW CREAT 000XIJKU*XIJKV INTO RIJ MTX
      REWIND 8
      CALL INIT(RIJ)
      DO 300 I=1,P
      DO 300 J=1,P
      SU=0.D0
      DO 400 L3=1,R
      DO 400 L1=1,C
      DO 400 L2=1,N
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (X(I1),I1=1,P)
400   SU=SU+X(I)*X(J)
      RIJ(I,J)=SU
      CALL RWNDF(IB)
300   CONTINUE
C     CREAT ERROR MATRIX
      CALL INIT(E)
      CALL ENDIO
      DO 500 I=1,P
      DO 501 J=1,P
      SU=0.D0
      DO 600 K=1,R
      DO 600 L=1,C
      READ(8,51) (X(I1),I1=1,P)
      SU=SU+X(I)*X(J)
600   CONTINUE
      REWIND 8
      CALL ENDIO
501   E(I,J)=RIJ(I,J)-SU/N
500   CONTINUE
      IF(IPT.NE.1) GO TO 564
      WRITE(IUNIT,565)
565   FORMAT(///,5X,"ERROR MATRIX")
      DO 156 I=1,P
```

```
      WRITE(IUNIT,52) I
156   WRITE(IUNIT,53) (E(I,J),J=1,P)
564   REWIND 8
      CALL RWNDF(IB)
      CALL INIT(RIJ)
      DO 101 I=1,30
101   G(I)=0.D0
      DO 100 I=1,R
      DO 100 J=1,C
      DO 100 K=1,N
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (X(I1),I1=1,P)
      DO 100 L=1,P
      G(L)=G(L)+X(L)
      RIJ(I,L)=RIJ(I,L)+X(L)
100   CONTINUE
      IF(IPT1.NE.1) GO TO 36
      WRITE(IUNIT,37)
37    FORMAT(///,"      ROW TREATMENT TOTALS",//)
      DO 110 I=1,R
      WRITE(IUNIT,52) I
52    FORMAT(5X,"ROW # ",I5)
110   WRITE(IUNIT,53) (RIJ(I,J),J=1,P)
53    FORMAT(4(4X,D16.11))
36    RN=R*N
      CN=C*N
      RCN=R*C*N
      CALL ENDIO
      DO 200 I=1,P
      DO 200 J=1,P
      SU=0.D0
      DO 202 K=1,R
202   SU=SU+RIJ(K,I)*RIJ(K,J)
      SU=SU/CN-G(I)*G(J)/RCN
      WRITE(8,511) SU
511   FORMAT(D20.13)
200   CONTINUE
      CALL RWNDF(IB)
      REWIND 8
      CALL ENDIO
      DO 203 I=1,P
      DO 203 J=1,P
      READ(8,511) RIJ(I,J)
203   RIJ(I,J)=RIJ(I,J)+E(I,J)
      CALL MINV(RIJ,P,DET2)
      CALL INIT(RIJ)
      DO 92 I=1,R
      DO 92 J=1,C
      DO 92 K=1,N
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (X(I1),I1=1,P)
      DO 92 L=1,P
92    RIJ(J,L)=RIJ(J,L)+X(L)
      IF(IPT1.NE.1) GO TO 38
```

```
      WRITE(IUNIT,35)
35    FORMAT(///,5X,"COLUMN TREATMENT TOTALS",//)
      DO 210 I=1,C
      WRITE(IUNIT,39) I
39    FORMAT(5X,"COLUMN",I7)
210   WRITE(IUNIT,53) (RIJ(I,J),J=1,P)
38    DO 94 I=1,P
      DO 94 J=1,P
      SU=0.D0
      DO 95 K=1,C
95    SU=SU+RIJ(K,I)*RIJ(K,J)
      SU=SU/RN-G(I)*G(J)/RCN
      WRITE(8,511) SU
94    CONTINUE
      CALL RWNDF(IB)
      REWIND 8
      J2=P*P
      CALL ENDIO
      DO 912 I=1,J2
912   READ(8,511) SU
      DO 99 I=1,P
      DO 99 J=1,P
      READ(8,511) RIJ(I,J)
99    RIJ(I,J)=RIJ(I,J)+E(I,J)
      REWIND 8
      CALL MINV(RIJ,P,DET3)
      CALL INIT(RIJ)
C     SUB H1,H2,E FROM TOTAL GET HE STORE IN TIJ
      DO 3000 I=1,P
      DO 3000 J=1,P
      SU=0.D0
      DO 4000 L3=1,R
      DO 4000 L1=1,C
      DO 4000 L2=1,N
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (X(I1),I1=1,P)
4000  SU=SU+X(I)*X(J)
      RIJ(I,J)=SU-G(I)*G(J)/RCN
      CALL RWNDF(IB)
3000  CONTINUE
      CALL CLOSE(IB)
      CALL ENDIO
      DO 1001 I1=1,2
      DO 1001 I=1,P
      DO 1001 J=1,P
      READ(8,511) X(1)
1001  RIJ(I,J)=RIJ(I,J)-X(1)
      CALL MINV(RIJ,P,DET1)
      CALL MINV(E,P,DETE)
      DET1=DETE/DET1
      DET2=DETE/DET2
      DET3=DETE/DET3
C     DET1,DET2,DET3 CONTAIN U -STATISTIC FOR H1,H2,H3 HYPOTH
```

```
      J1=R-1
      J2=C-1
      J3=J1*J2
      K=R*C*(N-1)
C    DFARE P,J(I),K
      WRITE(IUNIT,409) DET1,P,J1,K,DET2,P,J2,K,DET3,P,J3,K
409   FORMAT(//,10X,"HYPOTHESIS TEST RESULTS",//,5X,"HYPOTHESIS OF ",
     $10X,"U-STATISTIC",10X,"DEGREES OF FREEDOM",//,5X,
     1"INTERACTION EFFECT ",5X,D16.11,5X,3I7,/,5X,"FACTOR A EFFECT",
     26X,D16.11,5X,3I7,/,5X,"FACTOR B EFFECT",8X,D16.11,5X,3I7)
C     PLACE FPROB HERE IN WANTED
      END
      SUBROUTINE ENDIO
C     SUB. TO WAIT UNTIL TAPE IS FREE
10    CALL EXEC(13,108,I1,I2,I3)
      IF(I1.LT.0) GO TO 10
      RETURN
      END
      SUBROUTINE INIT(RIJ)
      DOUBLE PRECISION RIJ(30,30)
      DO 10 I=1,30
      DO 10 J=1,30
10    RIJ(I,J)=0.D0
      RETURN
      END
      END$
```

D. Regression and Factor Analysis

SREGR (Simple Linear Regression)

Purpose:

This program performs a simple linear regression, and provides an ANOVA goodness of fit which tests the aptness of the model.

Mathematical Model:

The model for the regression analysis is:

$$Y_i = b_0 + b_i x_i$$

where:

$i = 1$ to N, the number of observations

User Considerations and Procedures:

1. Program expects a data file to be created (see DA30) with N records. Each record has two variables, X and Y, which are arranged in that order.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

    a. number of observations (maximum 32767)

    b. name of data file

    c. format of data file

5. Printout gives:

    a. raw data (optional)

    b. $\overline{X}$ and $\overline{Y}$

    c. estimated value of B_0 and B_1

    d. ANOVA source table

    e. R value

    f. standard error of B_0 and B_1

Test Data:

This program was tested using data from John Neter and William Wasserman, Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Design, Richard D. Irwin, Inc., 1974, P. 93. The program uses double precision.

```
RU,SREGR
SIMPLE REGRESSION, Y=BØ  +  B1*X
DATA ENTER AS X THEN Y
ENTER NAME OF FILE FROM DA3Ø
#SREGR
ENTER FORMAT OF DATA
(2(3X,F5.1))
ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER Ø
1
ENTER 1 FOR CRT DISPLAY, 6 FOR LINEPRINTER
6
ENTER IN NUMBER OF OBSERVATIONS
1Ø
:
```

RAW DATA

X	Y
30.0	73.0
20.0	50.0
60.0	128.0
80.0	170.0
40.0	87.0
50.0	108.0
60.0	135.0
30.0	69.0
70.0	148.0
60.0	132.0

BAR = 50.0000 YBAR = 110.0000

B0 = 10.00000000
B1 = 2.00000000

SOURCE	SS	DF	MS	F	P(F)
MODEL	13600.0000	1	13600.0000	1813.3333	.000003
ERROR	60.0000	8	7.5000		
TOTAL	13660.0000	9			

R = .997801
STANDARD ERROR OF B0 = 2.50294
STANDARD ERROR OF B1 = .14852

```
"SREGR T=00003 IS ON CR00002 USING 00012 BLKS R=0000

FTN4
      PROGRAM SREGR
      REAL MSE,MSR
      DOUBLE PRECISION X,Y,SUMX,SUMY,SUMX2,SUMY2,SUMXY,R,B0,
     &B1,DEN,XN,SX,SY,SXY,SSTO,SSE,MSE,MSR,SB0,SB1
      DIMENSION IB(144),IBUF(128),NAME(3),IFMT(20)
      WRITE(1,10)
   10 FORMAT("SIMPLE REGRESSION, Y=B0 + B1*X")
      WRITE(1,11)
   11 FORMAT("ENTER NAME OF FILE FROM DA30")
      READ(1,12) NAME
   12 FORMAT(3A2)
      WRITE(1,13)
   13 FORMAT("ENTER FORMAT OF DATA")
      READ(1,14) IFMT
14    FORMAT(20A2)
      CALL OPEN(IB,IER,NAME,3,0,-2,128)
      IF(IER.GE.0) GO TO 20
      WRITE(1,15) NAME,IER
   15 FORMAT(3A2,"FAILED TO OPEN , IER = ",I5)
      STOP 15
20    WRITE(1,16)
   16 FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA,ELSE ENTER 0")
      READ(1,*) IPTO
      WRITE(1,18)
   18 FORMAT("ENTER 1 FOR CRT DISPLAY, 6 FOR LINEPRINTER")
      READ(1,*) IUNIT
      WRITE(1,17)
   17 FORMAT("ENTER IN NUMBER OF OBSERVATIONS")
      READ(1,*) N
      IF(IPTO.EQ.1) WRITE(IUNIT,99)
99    FORMAT(" RAW DATA "/,"     X          Y       "/)
      DO 30 I=1,N
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) X,Y
      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) X,Y
      SUMX=SUMX+X
      SUMY=SUMY+Y
      SUMX2=SUMX2+X*X
      SUMY2=SUMY2+Y*Y
30    SUMXY=SUMXY+X*Y
      XN=N
      DEN=XN*SUMX2-SUMX*SUMX
      B0=(SUMY*SUMX2-SUMX*SUMXY)/DEN
      B1=(XN*SUMXY-SUMX*SUMY)/DEN
      XBAR=SUMX/XN
      YBAR=SUMY/XN
```

```
      SXY=SUMXY-SUMX*SUMY/XN
      SX=SUMX2-SUMX*SUMX/XN
      SY=SUMY2-SUMY*SUMY/XN
      R=SXY/DSQRT(SX*SY)
      R=SXY/DSQRT(SX*SY)
      SSTO=SUMY2-XN*YBAR*YBAR
      SSE=SUMY2-B0*SUMY-B1*SUMXY
      MSR=SSTO-SSE
      MSE=SSE/(XN-2.)
      F=MSR/MSE
      DF1=1
      DF2=N-2
      CALL FPROB(F,DF1,DF2,Z,P)
      SB0=DSQRT(MSE*(1./XN+XBAR*XBAR/SX))
      SB1=DSQRT(MSE/SX*XN)
      WRITE(IUNIT,190) XBAR,YBAR
190   FORMAT(//,"XBAR = ",F10.4,"    YBAR = ",F10.4,//)
      WRITE(IUNIT,908) B0,B1
908   FORMAT(" B0 = ",F14.8,/," B1 = ",F14.8/)
      WRITE(IUNIT,100)
100   FORMAT(//"SOURCE",8X,"SS",10X,"DF",10X,"MS",10X,"F",10X,
     C"P(F)"/)
      DF3=DF1+DF2
      SSR=MSR
      WRITE(IUNIT,110) SSR,DF1,MSR,F,P,SSE,DF2,MSE,SSTO,DF3
110   FORMAT(" MODEL",5X,F10.4,3X,F5.0,2(3X,F10.4),3X,F10.6,/" ERROR"
     $,5X,F10.4,3X,F5.0,3X,F10.4,/" TOTAL",5X,F10.4,3X,F5.0)
      WRITE(IUNIT,120) R,SB0,SB1
120   FORMAT(//," R= ",F10.6,/" STANDARD ERROR OF B0 = ",F10.5,/,
     $" STANDARD ERROR OF B1 = ",F10.5)
      CALL CLOSE(IB)
      END
      END$
```

SRM30 (Correlation Matrix)

Purpose:

This program creates a correlation matrix from raw data. The matrix is required for the factor analysis (FATAA) and multiple regression (MRMAIN) programs.

User Considerations and Procedures:

1. A matrix data file must be created with n point per record.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. The correlation matrix can be saved in the file SRDATA. This matrix is necessary for FATAA and/or MRMAIN. To save this matrix, enter 1 for yes, 0 for no.

4. Parameters required:

   a. number of variables (maximum 30)

   b. name, format, and record length of data file (see DA30)

   c. number of subjects (maximum 32767)

   d. names of the n variables (maximum 8 characters per name, one name per line)

   e. scratch file name - do not use the same SCRTCH. This file is a working file and is destroyed upon completion of SRM30.

   f. number of variables per line for output

5. Printout gives:

   a. number of variables

   b. number of subjects

   c. two-tailed significance level

   d. $\overline{X}$, SD, name of each variable

   e. correlation matrix

Comments:

Whenever the option to save the correlation matrix is specified, the previous content in the SRDATA file is destroyed. Therefore, FATAA and/or MRMAIN should be run before using SRM30 again in order to preserve the data files. If this cannot be done, save the contents of SRDATA in another file. It will be necessary to dump the preserved data file into SRDATA before FATAA and/or MRMAIN analyses are done.

Test Data:

This program was tested using data presented on the next page. The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to six digit places instead of ten digits.

Variables

Subject	1	2	3	4	5	6	7	8
0001	24.00	81.00	992.00	1024.0	978.00	1101.0	935.00	1120.0
0002	25.00	22.00	181.00	310.00	293.00	346.00	188.00	166.00
0003	27.00	57.00	124.00	172.00	166.00	491.00	154.00	83.00
0004	29.00	36.00	553.00	719.00	605.00	833.00	585.00	346.00
0005	30.00	54.00	1046.0	2221.0	1841.0	2656.0	1062.0	1030.0
0006	31.00	25.00	322.00	522.00	402.00	676.00	261.00	379.00
0007	32.00	78.00	838.00	364.00	222.00	433.00	1014.0	584.00
0008	35.00	80.00	575.00	405.00	456.00	320.00	789.00	320.00
0009	36.00	30.00	835.00	811.00	716.00	824.00	735.00	975.00
0010	37.00	80.00	1001.0	166.00	179.00	154.00	907.00	1065.0
0011	37.00	57.00	1418.0	1706.0	1656.0	1759.0	1024.0	219.00
0012	45.00	74.00	531.00	503.00	581.00	593.00	481.00	593.00
0013	77.00	66.00	218.00	637.00	681.00	591.00	300.00	201.00
0014	80.00	47.00	133.00	109.00	112.00	106.00	166.00	108.00
0015	80.00	80.00	74.00	100.00	115.00	90.00	79.00	68.00
0016	80.00	74.00	550.00	322.00	422.00	204.00	600.00	400.00
0017	18.00	61.00	72.00	429.00	456.00	411.00	405.00	856.00
0018	19.00	18.00	67.00	760.00	856.00	509.00	966.00	3216.0
0019	20.00	80.00	173.00	434.00	311.00	511.00	103.00	139.00
0020	20.00	15.00	209.00	422.00	573.00	250.00	230.00	110.00
0021	22.00	29.00	18.00	1024.0	1114.0	853.00	687.00	671.00
0022	22.00	56.00	98.00	267.00	229.00	341.00	206.00	106.00
0023	22.00	7.00	21.00	752.00	795.00	491.00	1252.0	1308.0
0024	24.00	14.00	292.00	1312.0	1324.0	1296.0	1342.0	1851.0
0025	80.00	51.00	116.00	777.00	1034.0	548.00	880.00	952.00
0026	74.00	51.00	13.00	392.00	390.00	394.00	243.00	265.00
0027	64.00	46.00	19.00	318.00	292.00	348.00	156.00	134.00
0028	60.00	37.00	42.00	703.00	787.00	578.00	142.00	257.00
0029	59.00	18.00	345.00	899.00	778.00	1141.0	424.00	411.00
0030	54.00	14.00	49.00	968.00	747.00	1521.0	925.00	857.00
0031	54.00	71.00	16.00	503.00	421.00	964.00	275.00	226.00
0032	51.00	53.00	15.00	198.00	201.00	193.00	591.00	236.00
0033								
0034								

```
 RU,SRM3Ø
SRMAIN3Ø
ENTER # DATA VARIABLES:
8
ENTER INPUT FILE NAME:
#FATAA
ENTER INPUT DATA FORMAT (SUBJ DATA ACROSS):
(8(2X,F6.2))
 ENTER THE RECORD LENGTH AS IN DA3Ø
64
ENTER # SS:
32
DESIRE TO SAVE OUTPUT FOR MR?  (1=YES, Ø=NO):
1
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
ENTER VARIABLE NAMES (MAX 8 CHARACTERS EACH):
A
B
C
D
E
F
G
H
ENTER NAME OF SCRATCH FILE.
IF YOU ARE CONSIDERING NAMING YOUR SCRATCH FILE 'SCRATCH'
 PLEASE NOTE THAT THE PRINCIPAL FACTORS PROGRAM FATAA
 ESTABLISHES A FILE WITH SUCH A NAME FOR USE IN THAT PARTI-
 CULAR PROGRAM.  IN ORDER TO SAVE YOURSELF SOME TIME OR TO
 AVOID ERRORS (IF YOU INTEND TO USE FATAA) IT IS TO YOUR
 BENEFIT NOT TO NAME THIS FILE 'SCRATCH.'
 SCRATCH FILE NAME =
HELLO

ENTER # VBS. PER PAGE FOR OUTPUT:
8



SRM3Ø IS NOW FINISHED
:
```

NUMBER OF VARIABLES = 8
NUMBER OF SUBJECTS = 32

TWO-TAILED SIGNIFICANCE LEVELS

P = .050	P = .010	P = .005	P = .001
.29635	.35203	.46338	.59090

VB	MEAN	SD	
1	42.750	21.350	A
2	48.812	23.575	B
3	342.375	374.970	C
4	632.781	457.059	D
5	616.656	422.742	E
6	672.687	534.885	F
7	565.875	370.204	G
8	601.625	636.181	H

	1	2	3	4	5	6	7	8
1	1.0000	.2301	-.2057	-.2388	- 2014	-.2070	-.3045	-.3451
2	.2301	1.0000	.3379	-.2689	-.2920	-.1948	-.1690	-.3307
3	-.2057	.3379	1.0000	.4819	.4241	.4659	.4920	.0846
4	-.2388	-.2689	.4819	1.0000	.9689	.9375	.6105	.3755
5	-.2014	-.2920	.4241	.9689	1.0000	.8408	.6300	.4281
6	-.2070	-.1948	.4659	.9375	.8408	1.0000	.4869	.2326
7	-.3045	-.1690	.4920	.6105	.6300	.4869	1.0000	.6872
8	-.3451	-.3307	.0846	.3755	.4281	.2326	.6872	1.0000

"SRM30 T=00004 IS ON CR00002 USING 00025 BLKS R=0199

```
FTN4
          PROGRAM SRM30
          INTEGER XNAME
          DOUBLE PRECISION XBAR(30),SIG(30),R(30,60),X(30)
          DOUBLE PRECISION VAR
          DIMENSION IB(272),IC(272),ID(272),IBUF(256)
          DIMENSION ISIZE(2),IA(3),NAMA(3),NAMB(3)
          DIMENSION XNAME(10,4),INFILE(3),IFMT(20),ISCTCH(3)
          COMMON XBAR,SIG,R,X,VAR
          DATA IA/2HSR,2HDA,2HTA/
          DATA NAMA/2HMR,2HM3,1H0/
          DATA NAMB/2HFA,2HTA,1HA/
          WRITE(1,4400)
 4400     FORMAT ( "&SRMAIN30"  )
          WRITE(1,4401)
 4401     FORMAT ( "&ENTER # DATA VARIABLES: ")
          READ(1,*)  L
          WRITE(1,4402)
 4402     FORMAT ( "&ENTER INPUT FILE NAME:"  )
          READ(1,2)INFILE
 2        FORMAT(3A2)
          WRITE(1,4406)
 4406     FORMAT ( "&ENTER INPUT DATA FORMAT (SUBJ DATA ACROSS):" )
          READ(1,231)IFMT
 231      FORMAT(20A2)
          WRITE(1,88)
 88       FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
          READ(1,*)LENGTH
          LEN=LENGTH/2
          IF((LEN*2).NE.LENGTH) LEN=LEN+1
          LENGTH=LEN
          IDCBS=LENGTH
          IF(LENGTH.LT.144) IDCBS=144
          WRITE(1,4403)
 4403     FORMAT ( "&ENTER # SS: ")
          READ(1,*)  KNT
          WRITE(1,4404)
 4404     FORMAT ( "&DESIRE TO SAVE OUTPUT FOR MR? (1=YES; 0=NO):  ")
          READ(1,*) NPCH
 25       WRITE(1,4405)
 4405     FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
          READ(1,*) IUNIT
          IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 25
          IF(NPCH.LE.0)GO TO 27
 27       CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
          IF(IER.GE.0) GO TO 800
          WRITE(1,801) INFILE,IER
 801      FORMAT(" NO OPEN DATA FILE ",3A2,"  IER = ",I5)
          STOP 701
```

```
800   DO 5 K=1,30
      XBAR(K)=0
      SIG(K)=0
      DO 275 I=1,4
275   XNAME(K,I)=0
      DO 5 J=1,60
5     R(K,J)=0
      WRITE(1,4407)
4407  FORMAT ( "$ENTER VARIABLE NAMES (MAX 8 CHARACTERS EACH): "   )
      DO 19 I=1,L
      READ(1,4)(XNAME(I,J),J=1,4)
4     FORMAT(4A2)
19    CONTINUE
      NS=0
      WRITE(1,4408)
4408  FORMAT ( "$ENTER NAME OF SCRATCH FILE." )
      WRITE(1,4409)
4409  FORMAT ("IF YOU ARE CONSIDERING NAMING YOUR SCRATCH FILE",
     1" 'SCRATCH ")
      WRITE(1,4410)
4410  FORMAT("PLEASE NOTE THAT THE PRINCIPAL FACTORS PROGRAM FATAA")
      WRITE(1,4411)
4411  FORMAT (" ESTABLISHES A FILE WITH SUCH A NAME FOR USE",
     2"IN THAT PAR-")
      WRITE(1,4412)
4412  FORMAT(" TICULAR PROGRAM. IN ORDER TO SAVE YOURSELF SOME TIME")
      WRITE(1,4413)
4413  FORMAT (" OR TO AVOID ERRORS (IF YOU INTEND TO USE FATAA) IT")
      WRITE(1,4414)
4414  FORMAT(" IS TO YOUR BENEFIT NOT TO NAME THIS FILE 'SCRATCH'.")
      WRITE(1,4415)
4415  FORMAT ( " SCRATCH FILE NAME=  "   )
      READ(1,2)ISCTCH
      ISIZE(2)=LENGTH
      XSU=KNT
      SIZE=LENGTH
      SIZE=XSU*SIZE/128. + 1.
      ISIZE(1)=SIZE
      CALL CREAT(IC,IER,ISCTCH,ISIZE,2,0,-2,IDCBS)
      IF(IER.GE.0) GO TO 810
      WRITE(1,809) ISCTCH,IER
809   FORMAT("  NO OPEN SCRATCH FILE ",3A2," IER = ",I5)
      CALL CLOSE(IB)
      STOP 702
810   DO 11 JM=1,KNT
      CALL READF(IB,IER,IDUF)
      CALL CODE
      READ(IDUF,IFMT)(X(I),I=1,L)
      NS=NS+1
      DO 7 J=1,L
7     XBAR(J)=XBAR(J)+X(J)
      CALL CODE
      WRITE(IDUF,IFMT)(X(J),J=1,L)
      CALL WRITF(IC,IER,IDUF)
11    CONTINUE
      CALL CLOSE(IC)
      DO 9 J=1,L
```

```
 9      XBAR(J)=XBAR(J)/NS
        CALL OPEN(IC,IER1,ISCTCH,3,0,-2,IDCBS)
        IF(IER1.GE.0) GO TO 820
        WRITE(1,801) ISCTCH,IER1
        CALL CLOSE(IB)
        STOP 703
 820    DO 1400 JM=1,NS
        CALL READF(IC,IER,IDUF)
        CALL CODE
        READ(IDUF,IFMT)(X(J),J=1,L)
        DO 1400 J=1,L
        DO 1400 K=1,L
 1400   R(J,K)=R(J,K)+(X(J)-XBAR(J))*(X(K)-XBAR(K))
        CALL CLOSE(IC)
        DO 1401 J=1,L
        VAR=R(J,J)/NS
        IF(VAR.EQ.0.0)GO TO 1408
        SIG(J)=DSQRT(VAR)
        GO TO 1401
 1408   SIG(J)=0.0
 1401   CONTINUE
        DO 1402 J=1,L
        DO 1402 K=J,L
        R(J,K)=R(J,K)/NS
        IF(SIG(J)*SIG(K).NE.0.0)GO TO 1406
        R(J,K)=0
        GO TO 1407
 1406   R(J,K)=R(J,K)/(SIG(J)*SIG(K))
 1407   R(K,J)=R(J,K)
 1402   CONTINUE
        WRITE(IUNIT,98)L,NS
 98     FORMAT(" NUMBER OF VARIABLES = ",I3/
       $" NUMBER OF SUBJECTS = ",I5)
        SS=NS
        SE=1./SQRT(SS-1)
        SA=1.65*SE
        SB=1.96*SE
        SC=2.58*SE
        SD=3.29*SE
        IF(NPCH.LE.0)GO TO 91
        CALL OPEN(ID,IER,IA,3,0,-2,256)
        IF(IER.GE.0) GO TO 840
        WRITE(1,801) IA,IER
        CALL CLOSE(IB)
        CALL CLOSE(IC)
        STOP 740
 840    DO 802 J2=1,60
        CALL CODE
        WRITE(IDUF,94)(R(J1,J2),J1=1,30)
 94     FORMAT(30(2X,F10.4))
        CALL WRITF(ID,IER,IDUF)
 802    CONTINUE
        CALL CODE
        WRITE(IDUF,94) XBAR
        CALL WRITF(ID,IER,IDUF)
        CALL CODE
```

```
        WRITE(IDUF,94) SIG
        CALL WRITF(ID,IER,IDUF)
        CALL CODE
        WRITE(IDUF,808) ((XNAME(I1,I2),I2=1,4),I1=1,30)
        CALL WRITF(ID,IER,IDUF)
808     FORMAT(30(4X,4A2))
91      WRITE(IUNIT,13)
13      FORMAT(/"              VB.     MEAN        SD")
        DO 14 I=1,L
14      WRITE(IUNIT,15)I,XBAR(I),SIG(I),(XNAME(I,J),J=1,4)
15      FORMAT(9X,I3,2F10.3,10X,4A2)
100     WRITE(1,4416)
4416    FORMAT (  " " )
101     WRITE(1,4417)
4417    FORMAT (  "AENTER # VBS. PER PAGE FOR OUTPUT:  ")
        READ(1,*) NPAGE
        IF(NPAGE.GT.L)GO TO 101
        NPX=NPAGE-1
        KM=((L-1)/NPAGE+1)*NPAGE
        DO 995 M=NPAGE,KM,NPAGE
        LA=M-NPX
        IF(M-KM)997,996,997
996     M=L
997     WRITE(IUNIT,910)(I,I=LA,M)
910     FORMAT(/7X,10(I10,1X))
        DO 995 I=1,L
995     WRITE(IUNIT,930)I,(R(I,J),J=LA,M)
930     FORMAT(I5,F13.4,1X,9(F10.4,1X))
931     WRITE(1,4418)
4418    FORMAT(///,"SRM30 IS NOW FINISHED")
        CALL CLOSE(IB)
        CALL CLOSE(IC)
        CALL CLOSE(ID)
        CALL PURGE(ID,IER,ISCTCH)
        STOP
        END
        END$
```

MRMAIN (Multiple Regression Analysis)

Purpose:

This program performs a multiple regression analysis, arriving at a final equation using a forward stepwise procedure based on a maximum R-squared and F-test criteria.

Mathematical Model:

The model for the regression analysis is:

$$Y_i = B_0 + B_1X_{1i} + B_2X_{2i} + \dots B_jX_{ji} + E_i$$

where:

Y_i = i<u>th</u> observation of dependent variables

X_{ji} = i<u>th</u> observation of the j<u>th</u> independent variable

B_j = regression coefficient

E_i = normally distributed error term

User Considerations and Procedures:

1. Program requires input from SRM30. MRMAIN reads the file SRDATA created by SRM30 to receive the correlation matrix, variable means, standard deviation, and variable names.

2. Initial options and parameters:

   a. option for device output; enter 6 for line printer or 1 for CRT

   b. enter number of variables from SRM30 (maximum 30)

   c. enter the number of subjects on which correlation matrix is based

   d. enter number of the dependent variable (as entered in SRM30)

   e. enter minimum acceptable F for inclusion in equation - standard or typical value is 1

   f. enter the number of variables excluded from model, and those forced in model. If none are excluded, enter 0. If none are forced, enter 0

1) if the number excluded is not 0, program asks which variables are to be excluded. Enter the variable numbers of those to be excluded. These can be entered in any order separated by commas.
2) If the number forced is not 0, program asks how the variables are to be forced in the equation. Enter the variable numbers of the forced variables in the order they are to be forced. Separate the varables numbers by commas. (NOTE: forcing variables that are highly correlated to each other will cause stability problems.)

g. enter number of this equation - enter 1, usually

h. enter number of additional composites desired

i. in the following options, enter 1 for yes, 0 for no:

1) suppress weight reversals (0 forces $B_j \geq 0$)
2) multiply weights by 1000
3) set mean of predicted scores - if 1, program then asks you to enter the mean
4) set standard deviation of predicted score - if 1, program asks you to enter the standard deviation
5) check parameters, enter 1 if they are correct or 0 to restart

2. Options for storing data in order to plot the residuals: Enter 1 to plot residuals, 0 otherwise. (NOTE: If 1 is entered a scratch tape must be mounted. Residuals are outputted to magnetic tape as Y-criterion, Y-predicted in a (2(5X,F10.3)) format. To plot residuals run the program RESID. When this option is used, the name of raw data file and format of file is required.)

3. Printout gives:

a. copy of desired initial options and parameters

b. listing of variable names and corresponding $\overline{X}$, and standard deviation

c. as each variable is entered into the model the following information is given: number entered, variable numbers, cumulative multiple R, cumulative multiple R increase by this variable, R-square, shrunken R-squared, F-value for entering into model, degrees of freedom and probability of the F-value, and name of variable entered

d. after each vairable is entered, the following information is given: the number entered, the variable number, mean, standard deviation, Z-weight, raw score weight (B_j), critical R, Z-weight * critical R, and variable name

e. B_0 or constant is printed out for each step

Comments:

The scratch file is automatically purged from the disc at end of the MRMAIN run.

Test Data:

This program was tested using data presented below. The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to five or six digit places instead of ten digits except when variables are forced into the model that are too highly correlated, (i.e., > .99). In those cases accuracy is less than five digit places.

Subject	Independent Variable	Dependent Variable 1	2	3
1	19	1	1	1
2	28	2	2	2
3	17	1	-1	5
4	42	3	4	5
5	24	1	2	3
6	1	-1	-1	-1
7	8	-1	2	3
8	16	0	3	-3

```
 RU,MRMAIN
:SV,4
MRMAIN3Ø
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
ENTER # VBS IN MATRIX (MAX 3Ø):
4
ENTER # SS ON WHICH CORRELS BASED:
8
ENTER # OF CRIT VARIABLE:
1
ENTER MINIMUM ACCEPTABLE F FOR INCLUSION IN EQUATION:
1
ENTER # VBS EXCLUDED, & # VBS FORCED:
Ø,Ø
ENTER # OF THIS EQUATION:
1
ENTER # OF ADDITIONAL COMPOSITES DESIRED:
Ø
IN THE FOLLOWING DIALOG, 1 = YES, Ø = NO
SUPPRESS WT REVERSALS?
1
MULT WTS BY 1ØØØ?
Ø
SET MEAN OF PREDICTED  CORES?
Ø
SET SD OF PREDICTED SCORES?
Ø
SUPPRESS ADDITIONAL SHRUNKEN R ESTIMATES?
Ø
CHECK ABOVE PARAMETERS, ENTER 1 TO CONTINUE, Ø TO RESTART:
1
ENTER NAME OF SCRATCH FILE:
TECH 1
ENTER 1 TO PLOT RESIDUALS (Y-PRED VS Y-OBS):
1
 OUTPUT FILE FOR RESIDUALS IS MAG TAPE!
ENTER RAW DATA FILE NAME:
#MRM3Ø
ENTER RAW DATA FORMAT:
(4(4X,F1Ø.4))
MRM3Ø FINISHED
MRM3Ø ABORTED
```

SELECTED OPTIONS
VBS = 4
SS = 8
F-VALUE = 1
WT. REVERSALS SUPPRESSED.
INPUT FILE: SRDATA
SCRATCH FILE: TECH1

VB.	MEAN	ST. DEV.	
1	19.375	11.683	Y
2	.750	1.299	X
3	1.500	1.658	F
4	1.875	2.619	G

CRIT VB 1) Y MEAN: 19.375; SIGMA: 11.683

VARIABLE ADDED: 2) (CRIT. IS NO. 1 Y).

N.	VB.	CUM MULT R	INCREASE	R-SQUARE	SHRNKN R	F-VALUE	DF=1&	PROB(F)
1	2	.961600	.961600	.924675	.955050	73.6543	6	.00039

CORRECTED SHRUNKEN R ESTIMATES: .943 .939; CUM ERROR PROB: .000388

N	VB.	MEAN	SIGMA	Z-WEIGHT	RAW SCR WT	CRIT R	Z-WT*CRIT R	
1	2	.750	1.299	.96160	8.64825	.96160	.92467	X

CONSTANT: 12.889

VARIABLE ADDED: 3)(CRIT. IS NO. 1 Y)

N	VB.	CUM MULT R	INCREASE	R-SQUARE	SHRNKN R	F-VALUE	DF=1 &	PROB(F)
2	3	.995407	.033807	.990835	.993564	36.0956	5	.00256

CORRECTED SHRUNKEN R ESTIMATES: .992 .989; CUM ERROR PROB: .002946

N	VB.	MEAN	SIGMA	Z-WEIGHT	RAW SCR WT	CRIT R	Z-WT*CRIT R	
1	2	.750	1.299	.82680	7.43588	.96160	.79505	X
2	3	1.500	1.658	.29040	2.04587	.67420	.19579	F

CONSTANT: 10.729

VARIABLE ADDED: 4)(CRIT. IS NO. 1 Y).

N	VB.	CUM MULT R	INCREASE	R-SQUARE	SHRNKN R	F-VALUE	DF=1 &	PROB(F)
3	4	.997799	.002392	.995603	.996145	4.3379	4	.10515

CORRECTED SHRUNKEN R ESTIMATES: .995 .991; UM ERROR PROB: .107785

FINAL EQUATION:

N	VB.	MEAN	SIGMA	Z-WEIGHT	RAW SCR WT	CRIT R	Z-WT*CRIT R	
1	2	.750	1.299	.76987	6.92390	.96160	.74031	X
2	3	1.500	1.658	.31313	2.20600	.67420	.21111	F
3	4	1.875	2.619	.08558	.38175	.51630	.04419	G

CONSTANT: 10.157

INPUT RAW DATA FILE: #MRM30
INPUT DATA FORMAT: (4(4X,F1Ø.4))
RESIDUALS OUTPUT TO TAPE:
(CRITERION, Y-PREDICTED 2(5X,F1Ø.3) FORMAT)

```
MRMAIN T=00004 IS ON CR00002 USING 00001 BLKS R=0005

0001     :SV,4
0002     :RP,MRM30
0003     :RU,MRM31
0004     :OF,MRM30
0005     :SV,1
```

```
*MRM30 T=00004 IS ON CR00002 USING 00040 BLKS R=0325

FTN4
      PROGRAM MRM30
      COMMON IUNIT,HINC,IFIN,L,N,NC,FVAL,NEX,NFRCE,NTIME,NRPT,
     $NPOS,MULT,ICOM,TMN,TSIG,NSHR,AL,NPASS,ICOMM,NFA
      COMMON IRDFIL(3),IRFMT(20),RDATA(30)
      INTEGER RFMT(20),XNAME
      COMMON ISIZE(2),INFILE(3),IFMT(20)
      COMMON SGN(30),KFRCE(30),WT(30),KKX(30)
      COMMON X(60),NX(30)
      COMMON R(30,60),SIG(30),XBAR(30),XNAME(30,4)
      COMMON IB(272),IBUF(256)
      DIMENSION ISRD(3)
      DATA ISRD/2HSR,2HDA,2HTA/
1000  IF(NTIME.GT.1)GO TO 4000
3000  CALL OPEN(IB,IER,ISRD,3,0,-2,256)
      IF(IER.GE.0) GO TO 3010
      WRITE(1,4420) IER
4420  FORMAT ( "NO OPEN SRDATA, IER = ",I5 )
      STOP 4420
3010  WRITE(IUNIT,3020)
3020  FORMAT(" INPUT FILE: SRDATA")
      DO 4421 IJ=1,60
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,94) (R(JI,IJ),JI=1,30)
94    FORMAT(30(2X,F10.4))
4421  CONTINUE
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,94) XBAR
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,94) SIG
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,808) ((XNAME(I1,I2),I2=1,4),I1=1,30)
808   FORMAT(30(4X,4A2))
      CALL CLOSE(IB)
3150  IF(NTIME.GT.0)GO TO 4000
      IF(NRPT.LE.0)GO TO 4000
      NTIME=1
4000  CONTINUE
      EWP=1
      IG1=NFRCE
      IG2=NFA
      IG3=NEX
      IF(NTIME.NE.1)GO TO 4080
      WRITE(1,4430)
4430  FORMAT ( "&ENTER NAME OF SCRATCH FILE:" )
      READ(1,3071)INFILE
```

```
      ISIZE(1)=73
      ISIZE(2)=150
      CALL CREAT(IB,IER,INFILE,ISIZE,2,0,-2,150)
      IF(IER.GE.0)GO TO 4030
      WRITE(1,4431) IER
4431  FORMAT ( "NO OPEN SCRATCH FILE, IER = ",I5 )
      STOP 4431
4030  IF(IUNIT.EQ.6)WRITE(IUNIT,4040)INFILE
4040  FORMAT(" SCRATCH FILE: ",3A2)
      CALL CODE
      WRITE(IBUF,22) XBAR
22    FORMAT(30F10.4)
      CALL WRITF(IB,IER,IBUF)
      CALL CODE
      WRITE(IBUF,22) SIG
      CALL WRITF(IB,IER,IBUF)
      DO 4070 I=1,60
      CALL CODE
      WRITE(IBUF,22) (R(J,I),J=1,30)
4070  CALL WRITF(IB,IER,IBUF)
      CALL CLOSE(IB)
4080  IF(NTIME.LT.2)GO TO 4110
      CALL OPEN(IB,IER,INFILE,3,0,-2,150)
      IF(IER.GE.0)GO TO 4090
      WRITE(1,4433) IER
4433  FORMAT ( "NO RE-OPEN SCRATCH FILE, IER = ",I5  )
      STOP  4433
4090  CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,22) XBAR
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,22) SIG
      DO 4100 I =1,60
      CALL READF(IB,IER,IBUF)
      CALL CODE
4100  READ(IBUF,22) (R(J,I),J=1,30)
4110  WRITE(IUNIT,4120)
4120  FORMAT(//14X," VB.         MEAN            ST. DEV."//)
      KKM=NEX
      DO 4160 I=1,L
      SGN(I)=R(I,NC)
      IF(NEX.LE.0)GO TO 4140
      DO 4130 J=1,NEX
      KKX(J)=NX(J)
      NZ=NX(J)
      IF(I.EQ.NZ)GO TO 4160
4130  CONTINUE
4140  WRITE(IUNIT,4150)I,XBAR(I),SIG(I),(XNAME(I,J),J=1,4)
4150  FORMAT(14X,I3,5X,F10.3,5X,F10.3,5X,4A2)
4160  CONTINUE
      IF(TMN.GT.0.)XBAR(NC)=TMN
      IF(TSIG.GT.0.)SIG(NC)=TSIG
      K=L+1
      NT=2*L
```

```
      DO 4190 I=K,NT
      DO 4190 J=1,L
      M=J+L
      IF(I-M)4180,4170,4180
4170  R(J,I)=-1.0
      GO TO 4190
4180  R(J,I)=0
4190  CONTINUE
      IF(NEX)4220,4220,42000
42000 DO 4210 J=1,NEX
      NZ=NX(J)
      DO 4210 I=1,L
      R(NZ,I)=0.
4210  R(I,NZ)=0.
4220  AMA=0.
      OLDR=0.
      AN=N-1
      DO 4230 I=1,L
4230  NX(I)=0
      MFR=1
      TS=SIG(NC)
      IF(MULT.LE.0)GO TO 4240
      IF(TSIG.GT.0.)MULT=0
4240  IF(MULT.GT.0)TS=TS*1000.
5000  CONTINUE
      WRITE(IUNIT,5020)NC,(XNAME(NC,I),I=1,4),XBAR(NC),TS
5020  FORMAT("0*** CRIT VB ***",I4,"; ",4A2,"MEAN: ",F10.3,
     $"; SIGMA: ",F10.3)
5030  DO 5060 I=1,L
      IF(R(I,I)-.001)5040,5040,5050
5040  X(I)=0.
      GO TO 5060
5050  X(I)=(R(I,NC)**2)/R(I,I)
5060  CONTINUE
      X(NC)=0.
      IF(MFR.GT.NFRCE)GO TO 5070
      M=KFRCE(MFR)
      MFR=MFR+1
      TEMP=X(M)
      GO TO 5120
5070  IF(NPOS.LE.0)GO TO 5090
      DO 5080 I=1,L
      TEMP=R(I,NC)*SGN(I)
      IF(TEMP.LE.0.)X(I)=0.
5080  CONTINUE
5090  TEMP=X(1)
      M=1
      DO 5110 I=2,L
      IF(X(I)-TEMP)5110,5110,5100
5100  TEMP=X(I)
      M=I
5110  CONTINUE
5120  AMA=AMA+1.
      NFA=NFA-1
      DFA=AN-AMA
      V=R(NC,NC)-TEMP
```

```
      IF(V-.001)5130,5130,5140
5130  FRAT=1000.
      AMA=L
      GO TO 5150
5140  FRAT=(TEMP*DFA)/V
      IF(NFA.GE.0)GO TO 5150
      IF(FRAT-FVAL)6050,6050,5150
5150  IF(R(M,M).GT.0.001)GO TO 5160
      V=0.
      GO TO 5170
5160  V=1./SQRT(R (M,M))
5170  DO 5180 I=1,NT
5180  X(I)=R(M,I)*V
      DO 5190 I=1,L
      IF(X(I).EQ.0.)GO TO 5190
      DO 5190 J=1,NT
      IF(X(J).EQ.0.)GO TO 5190
      R(I,J)=R(I,J)-X(I)*X(J)
5190  CONTINUE
      R(M,M)=0.
      RMS=R(NC,NC)
      RKK=RMS*(AN/DFA)
      RSH=1.-RKK
      IF(NSHR.GT.0)GO TO 52000
      RSS5=1.-RKK*(1.+(AL/(2.*DFA)))
      RSS3=1.-RKK*((AN+2.)/(AN+1.))*((AN-1.)/(DFA-1.))
      IF(RSS5.GT.0.)RSS5=SQRT(RSS5)
      IF(RSS3.GT.0.)RSS3=SQRT(RSS3)
52000 IF(RSH.GT.0.)RSH=SQRT(RSH)
      RMS=1.-RMS
      RM=SQRT(RMS)
      UP=RM-OLDR
      K=AMA
      NDF=DFA
      PB=1.0
      CALL FPROB(FRAT,PB,DFA,ZZ,PP)
      PPB=1.-PP
      EWP=EWP*PPB
      EWR=1.-EWP
      WRITE(IUNIT,6010)M,NC,(XNAME(NC,I),I=1,4)
6010  FORMAT("0VARIABLE ADDED: ",I3,";(CRIT. IS NO.",I3,2X,4A2,").")
      WRITE(IUNIT,6020)
6020  FORMAT("   N.  VB.    CUM MULT R    INCREASE       R-SQUARE",
     $"       SHRNKN R     F-VALUE          DF=1 &      PROB(F)")
      WRITE(IUNIT,6030)K,M,RM,UP,RMS,RSH,FRAT,NDF,PP,(XNAME(M,I),
     CI=1,4)
6030  FORMAT(" ",I3,2X,I3,4(4X,F9.6),F11.4,8X,I5,7X,F8.5,5X,4A2)
      NINC=NINC+1
      OLDR=RM
      NX(M)=K
      KKM=KKM+1
      KKX(KKM)=M
      NCK=L-K-1-NEX
      IF(NSHR.GT.0)GO TO 6050
      WRITE(IUNIT,6040)RSS5,RSS3,EWR
6040  FORMAT(" "/" CORRECTED SHRUNKEN R ESTIMATES: ",2F12.3,
     $"; CUM ERROR PROB: ",F10.6/)
```

```
6050  K=L+1
      DO 6060 J=K,NT
      M=J-L
6060  WT(M)=R(NC,J)
      TEMP=0.
      NVBS=L-1-NEX
      IF(NFA.GE.0)GO TO 6080
      IF(FRAT.GT.FVAL.AND.NINC.LT.NVBS)GO TO 6080
6065  WRITE(IUNIT,6070)
6070  FORMAT("0      FINAL EQUATION: "/)
      IFIN=1
6080  CONTINUE
      DO 6100 J=1,L
      IF(NX(J).LE.0)GO TO 6100
      V=SIG(NC)/SIG(J)
      IF(TSIG.GT.0.)V=V/RM
      X(J)=WT(J)*V
      IF(MULT.LE.0)GO TO 6090
      XKTP=X(J)*1000.+0.5
      KTP=XKTP
      X(J)=KTP
6090  TEMP=TEMP+X(J)*XBAR(J)
6100  CONTINUE
      Z=XBAR(NC)-TEMP
      WRITE(IUNIT,6110)
6110  FORMAT("    N   VB.       MEAN             SIGMA      Z-WEIGHT",
     $"    RAW SCR WT      CRIT R   Z-WT*CRIT R"/)
      DO 6130 I=1,L
      PROD=SGN(I)*WT(I)
      IF(NX(I))6130,6130,6120
6120  WRITE(IUNIT,6150)NX(I),I,XBAR(I),SIG(I),WT(I),X(I),SGN(I),PROD,
     $(XNAME(I,J),J=1,4)
6130  CONTINUE
      WRITE(IUNIT,6140)Z
6140  FORMAT("        CONSTANT: ",F10.3)
6150  FORMAT(2X,I3,I4,4X,F10.3,3X,F10.3,3X,F9.5,F13.5,2(3X,F9.5)
     $5X,4A2)
      WRITE(IUNIT,6160)
6160  FORMAT(" ")
6161  GO TO 6168
65432 IPL=0
      WRITE(1,4500)
4500  FORMAT ( "ENTER 1 TO PLOT RESIDUALS (Y-PRED VS Y-OBS): " )
      READ(1,*)  IPL
      IF(IPL.EQ.0)GO TO 7000
      WRITE(1,4501)
4501  FORMAT(" OUTPUT FILE FOR RESIDUALS IS MAG TAPE!&A")
6162  WRITE(1,4503)
4503  FORMAT ( "ENTER RAW DATA FILE NAME:"   )
      READ(1,3071)IRDFIL
      WRITE(1,4504)
4504  FORMAT ( "ENTER RAW DATA FORMAT:" )
      READ(1,3070)IRFMT
      CALL OPEN(IB,IER,IRDFIL,3,0,-2,256)
      IF(IER.GE.0)GO TO 6163
      WRITE(1,4505) IER
4505  FORMAT ( "NO OPEN RAW DATA FILE, IER = ",I5   )
      STOP
```

```
6163  WRITE(IUNIT,61635)IRDFIL,IRFMT
      WRITE(IUNIT,61636)
61635 FORMAT("0INPUT RAW DATA FILE: ",3A2/" INPUT DATA FORMAT:",
     $20A2)
61636 FORMAT(" RESIDUALS OUTPUT TO TAPE: ",/" (CRITERION,"
     $"Y-PREDICTED 2(5X,F10.3) FORMAT)")
      DO 6166 I1=1,N
      YP=Z
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IRFMT)(RDATA(I2),I2=1,L)
      DO 6164 I2=1,L
      IF(NX(I2).GT.0)YP=YP+X(I2)*RDATA(I2)
6164  CONTINUE
      WRITE(8,8185)RDATA(NC),YP
8185  FORMAT(2(5X,F10.3))
6166  CONTINUE
6167  CALL CLOSE(IB)
      ENDFILE 8
      GO TO 7000
6168  IFIN=0
      IF(NCK.LE.0)GO TO 6170
      IF(FRAT.GT.FVAL)GO TO 5030
      IF(NFA.GE.0)GO TO 5030
6170  IF(NRPT.LE.0)GO TO 62000
      NPASS=NPASS+1
      IF(KKM.LE.0) GO TO 5647
      DO  6180 I=1,KKM
6180  NX(I)=KKX(I)
5647  NINC=0
      NTIME=2
      KKM=IG3
      NFRCE=IG1
      NFA=IG2
      WRITE(IUNIT,6190)NPASS
6190  FORMAT("1 EQUATION SET: ",I3," ATTEMPTED")
      NRPT=NRPT-1
      GO TO 4000
62000 CONTINUE
      GO TO 65432
7000  WRITE(1,4500)
4500  FORMAT("MRM30 FINISHED &&")
      CALL CLOSE(IB)
      CALL PURGE(IB,IER,INFILE)
      REWIND 8
3071  FORMAT(3A2)
3070  FORMAT(20A2)
      STOP 1234
      END
      END$
```

```
*MRM31 T=00003 IS ON CR00002 USING 00017 BLKS R=0000

FTN4
      PROGRAM MRM31
      COMMON IUNIT,NINC,IFIN,L,N,NC,FVAL,NEX,NFRCE,NTIME,NRPT,
     $NPOS,MULT,ICOM,TMN,TSIG,NSMR,AL,NPASS,ICOMM,NFA
      COMMON IRDFIL(3),IRFMT(20),RDATA(30)
      INTEGER RFMT(20),XNAME
      COMMON ISIZE(2),INFILE(3),IFMT(20)
      COMMON SGN(30),KFRCE(30),WT(30),KKX(30)
      COMMON X(60),NX(30)
      COMMON R(30,60),SIG(30),XBAR(30),XNAME(30,4)
      COMMON IB(272),IBUF(256)
      DIMENSION ISRD(3),NAM1(3)
      DATA ISRD/2HSR,2HDA,2HTA/
      DATA NAM1 /2HMR,2HM3,2H0 /
      WRITE(1,4400)
4400  FORMAT ( "KRMAIN30&"  )
1000  DO 1010 I=1,30
      SGN(I)=0
      KFRCE(I)=0
      WT(I)=0
      KKX(I)=0
      SIG(I)=0
      RDATA(I)=0.
      XBAR(I)=0
      NX(I)=0
      DO 1010 J=1,20
      RFMT(J)=2H
      IFMT(J)=2H
      DO 1010 K=1,60
      R(I,K)=0
      X(K)=0
1010  CONTINUE
900   WRITE(1,4401)
4401  FORMAT (  "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
      READ(1,*) IUNIT
      IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 900
      NINC=0
      IFIN=0
      WRITE(1,4402)
4402  FORMAT ( "&ENTER # VBS IN MATRIX (MAX 30): ")
      READ(1,*)  L
      WRITE(1,4403)
4403  FORMAT ( "&ENTER # SS ON WHICH CORRELS BASED:  ")
      READ(1,*) N
      WRITE(1,4404)
4404  FORMAT ( "&ENTER # OF CRIT VARIABLE: ")
      READ(1,*)  NC
      WRITE(1,4405)
4405  FORMAT("&ENTER MINIMUM ACCEPTABLE F FOR INCLUSION",
     C" IN EQUATION. ")
```

```
      READ(1,*)  FVAL
      WRITE(1,4406)
 4406 FORMAT ( "&ENTER # VBS EXCLUDED, & # VBS FORCED: ")
      READ(1,*)  NEX,NFRCE
      IF(NEX.GT.0) WRITE(1,543)
 543  FORMAT(" ENTER &#'S OF VBS. TO EXCLUDE (ANY ORDER): ")
      IF(NEX.GT.0) READ(1,*) (NX(I),I=1,NEX)
      IF(NFRCE.GT.0) WRITE(1,544)
 544  FORMAT("&ENTER #'S OF VBS. TO FORCE (IN DESIRED ORDER)!")
      IF(NFRCE.GT.0) READ(1,*) (KFRCE(I),I=1,NFRCE)
      WRITE(1,4407)
 4407 FORMAT ( "&ENTER # OF THIS EQUATION: ")
      READ(1,*)  NTIME
      WRITE(1,4408)
 4408 FORMAT ( "&ENTER # OF ADDITIONAL COMPOSITES DESIRED: ")
      READ(1,*)  NRPT
      NPOS=0
      MULT=0
      ICOM=0
      TMN=0
      TSIG=0
      NSHR=0
      WRITE(1,4410)
 4410 FORMAT ( "IN THE FOLLOWING DIALOG, 1 = YES, 0 = NO."   )
      WRITE(1,4411)
 4411 FORMAT ( "SUPPRESS WT REVERSALS? ")
      READ(1,*)  NPOS
      WRITE(1,4412)
 4412 FORMAT ( "MULT WTS BY 1000?  ")
      READ(1,*) MULT
      WRITE(1,4413)
 4413 FORMAT ( "SET MEAN OF PREDICTED SCORES?  ")
      READ(1,*) ICOM
      IF(ICOM.EQ.1) WRITE(1,531)
 531  FORMAT("&ENTER MEAN: ")
      IF(ICOM.EQ.1) READ(1,*) TMN
      WRITE(1,4414)
 4414 FORMAT ( "SET SD OF PREDICTED SCORES?  ")
      READ(1,*) ICOM
      IF(ICOM.EQ.1) WRITE(1,545)
 545  FORMAT("ENTER SD: ")
      IF(ICOM.EQ.1) READ(1,*) TSIG
      WRITE(1,4415)
 4415 FORMAT ( "SUPPRESS ADDITIONAL SHRUNKEN R ESTIMATES?  ")
      READ(1,*) NSHR
      AL=L-1-NEX
      NPASS=1
      WRITE(1,4418)
 4418 FORMAT ( "&CHECK ABOVE PARAMETERS, ENTER 1 TO CONTINUE, 0 TO",
     $"RESTART: ")
      READ(1,*)  ICOMM
      IF(ICOMM.EQ.0)GO TO 1000
20000 IF(IUNIT.NE.6)GO TO 2080
      WRITE(IUNIT,2010)
```

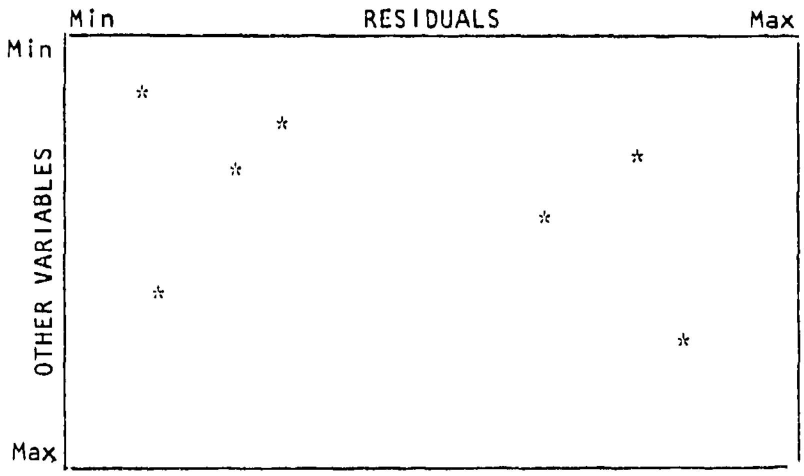
```
 2010  FORMAT("1   OUTPUT FROM MULTR2"/" *** SELECTED OPTIONS ***")
       WRITE(IUNIT,2020)L,N,FVAL
 2020  FORMAT(" # VBS = ",I3/" # SS = ",I3/" F-VALUE = ",F7.0)
 C ..... PRINT OPTIONS SELECTED
       IF(NFRCE.GT.0)WRITE(IUNIT,2030)(KFRCE(I),I=1,NFRCE)
 2030  FORMAT(" FORCING SEQUENCE: ",10I3)
       IF(NPOS.GT.0)WRITE(IUNIT,2040)
 2040  FORMAT(" WT. REVERSALS SUPPRESSED.")
       IF(NEX.GT.0)WRITE(IUNIT,2050)(NX(I),I=1,NEX)
 2050  FORMAT(//" VBS. EXCLUDED: ",10I3)
       IF(TMN.GT.0.)WRITE(IUNIT,2060)TMN
 2060  FORMAT(" ESTABLISH MEAN OF PREDICTED SCORES AT: ",F10.3)
       IF(TSIG.GT.0.)WRITE(IUNIT,2070)TSIG
 2070  FORMAT(" ESTABLISH STANDARD DEVIATION OF PREDICTED SCORES AT:"
      $,F10.3," [SD OF CRIT. WILL EQU: (SD OF PRED SCORE)/R]")
 2080  NTA=NFRCE
       CALL EXEC(9,NAM1)
       END
       END$
```

RESID (Residual Plot)

Purpose:

This program is used to calculate residuals from data obtained from the MRMAIN program and to plot the residuals against Y-HAT or another independent variable.

Graphic Display:



User Considerations and Procedures:

1. Program reads off magnetic tape, Y-criterion and Y-predicted values created by MRMAIN (see MRMAIN). RESID then calculates the residuals by the formula:

   Residuals = (Y-predicted) - (Y-criterion).

2. Option: enter 0 to plot Y-HAT (Y-predicted) vs residuals; enter variable number of raw data file to plot that independent variable vs residuals; enter -999 to end program.

3. Enter number of observations (program plots out residual for each observation).

4. Enter number of variables on raw data file.

5. Enter name of raw data file.

6. Enter format and record length of raw data file.

7. Enter 1 for CRT display or 6 for line printer display of data.

Comments:

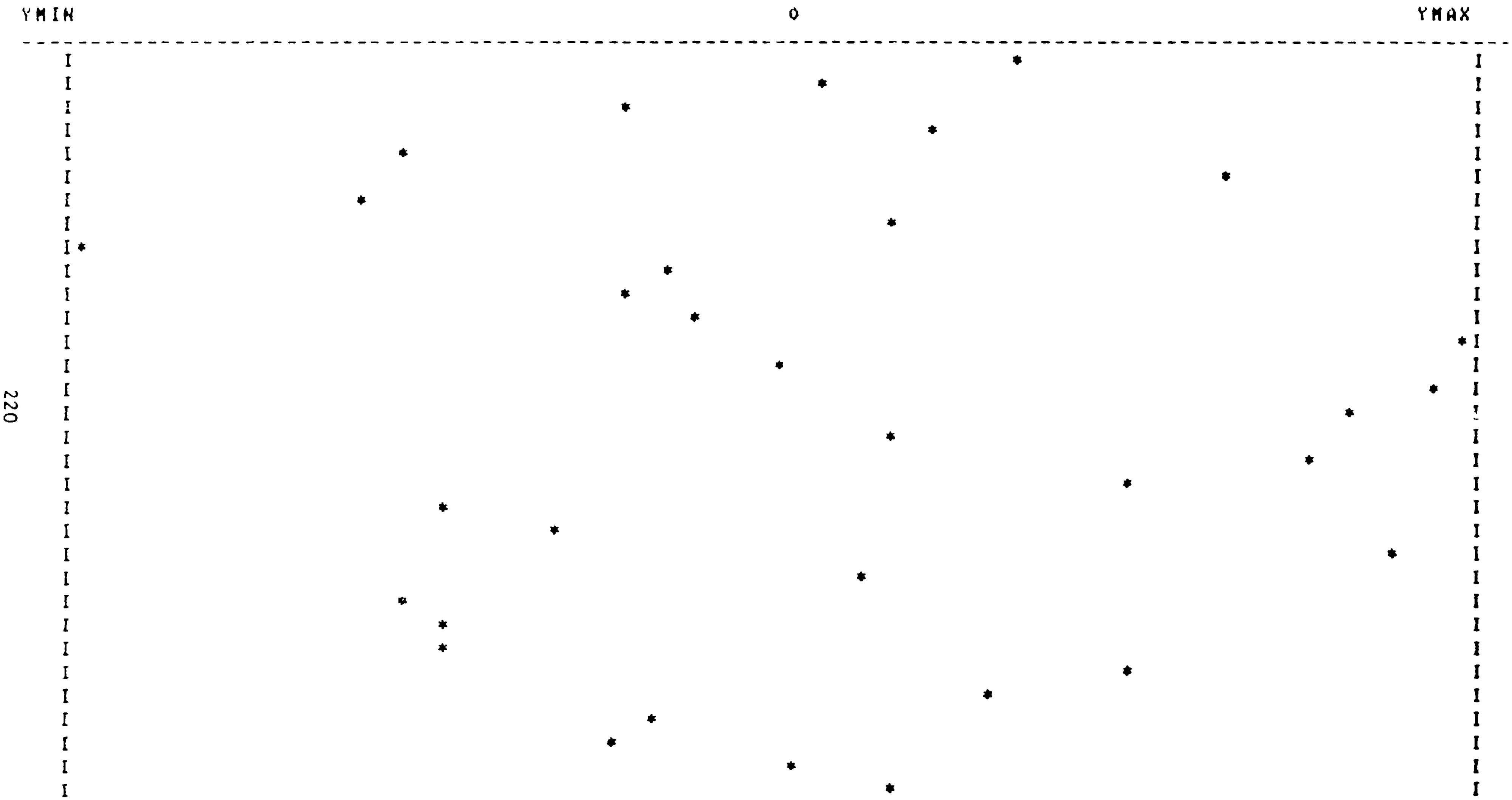
If the device chosen for display was the CRT, the program transfers the CRT graph to hardcopy before doing another plot. If a hardcopy is not desired, turn hardcopy unit off.

On line printer output, a cleaner representation can be obtained by turning the paper over so there are no lines on the printed page.

```
RU,RESID
PROGRAM TO ANALYSE RESIDUALS BY PLOTTING YHAT VS
RESIDUALS AND/OR ANY INDEPENDENT VARIABLE VS RESIDUALS


ENTER Ø TO PLOT YHAT
   VAR # TO PLOT THAT VARIABLE
    -999 TO STOP

Ø
ENTER NUMBER OF OBSERVATIONS
32
ENTER NUMBER OF VARIABLES
8
ENTER NAME OF DATA FILE NAME
#FATAA
ENTER FORMAT OF RAW DATA
(8(2X,F6.2))
 ENTER THE RECORD LENGTH AS IN DA3Ø
64
ENTER 1 FOR CRT, OR 6 FOR LINEPRINTER GRAPH
6


ENTER Ø TO PLOT YHAT
   VAR # TO PLOT THAT VARIABLE
    -999 TO STOP
2

ENTER Ø TO PLOT YHAT
   VAR # TO PLOT THAT VARIABLE
    -999 TO STOP
-999


:
```

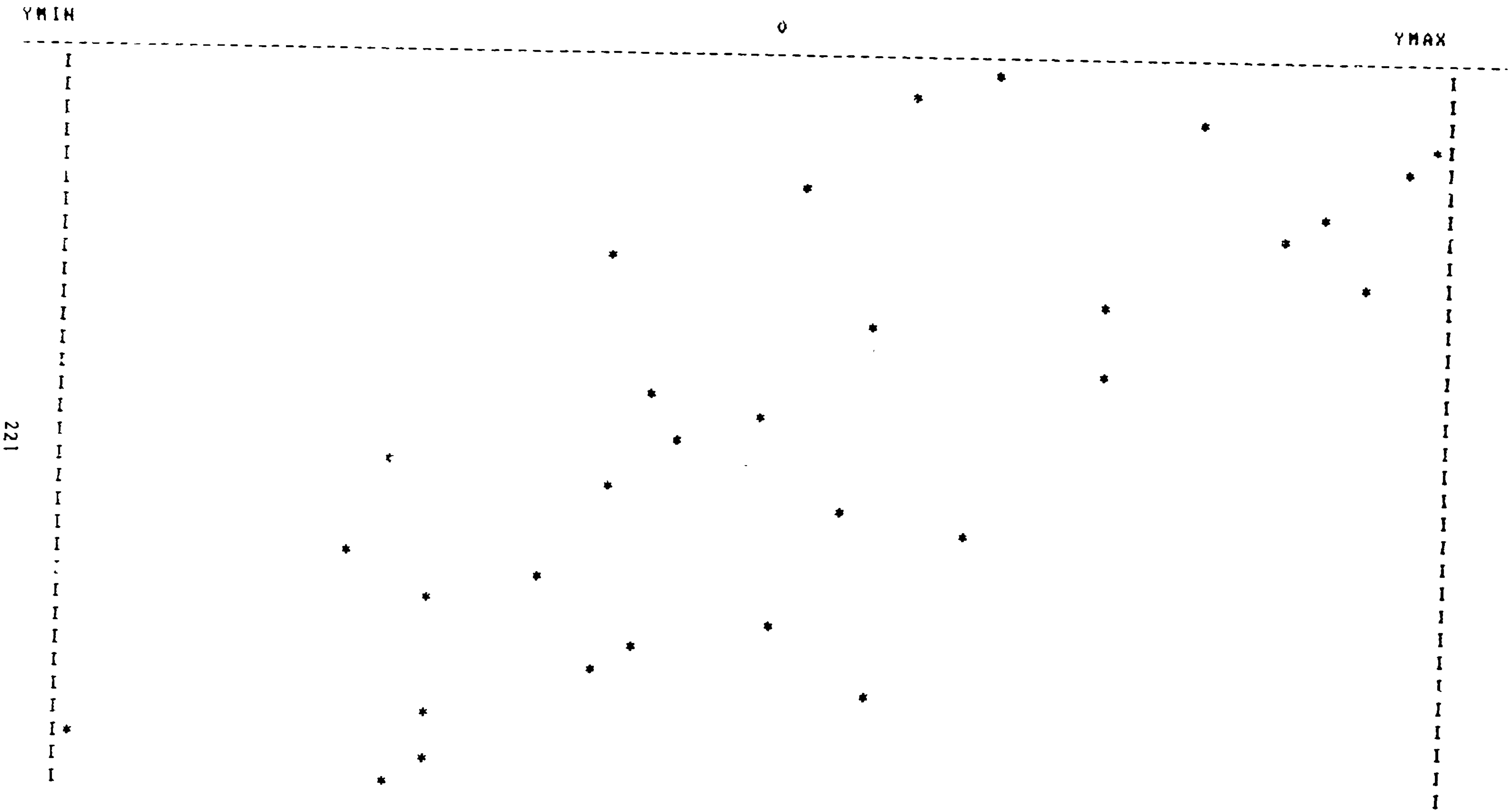
OPTION TAKEN 0

YMIN = -37.6070023 YMAX = 31.9739990



OPTION TAKEN 2

YMIN = -37.6070023 YMAX = 31.9739990



```
*RESID T=00003 IS ON CR00002 USING 00022 BLKS R=0000

FTN4,L,A
          PROGRAM RESID
          COMMON IUNIT,NSUB,X(2,1000),Y(30),IBUF(256),IB(272)
          COMMON IFMT(20),NAME(3),IC(120),ID(75)
          DO 10 I=1,120
10        IC(I)=2H
          DO 234 I=1,75
234       ID(I)=2H
          IC(1)=1H
          IC(2)=1HY
          IC(3)=1HM
          IC(4)=1HI
          IC(5)=1HN
          IC(102)=1HY
          IC(103)=1HM
          IC(104)=1HA
          IC(105)=1HX
          DO 103 I=1,5
103       ID(I)=IC(I)
          DO 104 I=1,4
104       ID(I+63)=IC(I+101)
          I78=15414B
          I77=15427B
          WRITE(1,1)
1         FORMAT(" PROGRAM TO ANALYSE RESIDUALS BY PLOTTING YHAT VS",
         $/," RESIDUALS AND/OR ANY INDEPENDENT VARIABLE VS RESIDUALS")
          NTIME=0
2         WRITE(1,3)
3         FORMAT(//"ENTER 0 TO PLOT YHAT ",/,5X,"VAR # TO PLOT THAT ",
         $"VARIABLE ",/,"       -999 TO STOP")
          READ(1,*) ICOM
          IF(ICOM.LT.0) GO TO 999
          IF(NTIME.NE.0) GO TO 100
          WRITE(1,4)
4         FORMAT("ENTER NUMBER OF OBSERVATIONS")
          READ(1,*) NSUB
          NTIME=NTIME+1
          WRITE(1,5)
5         FORMAT("ENTER NUMBER OF VARIABLES")
          READ(1,*) NVAR
          WRITE(1,6)
6         FORMAT("ENTER NAME OF DATA FILE NAME")
          READ(1,7) NAME
7         FORMAT(3A2)
          WRITE(1,8)
8         FORMAT("ENTER FORMAT OF RAW DATA")
          READ(1,9) IFMT
9         FORMAT(20A2)
          IDCBS=256
          CALL OPEN(IB,IERR,NAME,3,0,-2,IDCBS)
          IF(IERR.GE.0) GO TO 77
          WRITE(1,78) NAME,IERR
78        FORMAT(5X,3A2,"  FAILED TO OPEN ",I5," ERROR #")
          STOP
```

```
77     WRITE(1,4403)
4403   FORMAT("ENTER 1 FOR CRT , OR 6 FOR LINEPRINTER GRAPH")
       READ(1,*) IUNIT
       IF(IUNIT.NE.1) GO TO 100
       WRITE(1,83) I77,I78
83     FORMAT("TURN OF HARD COPY UNIT POWER, IF HARD COPY",/,5X,
      $"IS NOT DESIRED",2A2)
100    CONTINUE
       CALL RWNDF(IB)
       REWIND 8
       DO 15 I = 1,NSUB
       READ(8,11) CRIT,YHAT
11     FORMAT(2(5X,F10.3))
       RES=YHAT-CRIT
       IF(ICOM.EQ.0) GO TO 20
       CALL READF(IB,IER,IBUF)
       CALL CODE
       READ(IBUF,IFMT) (Y(J),J=1,NVAR)
       X(1,I)=Y(ICOM)
       GO TO 21
20     X(1,I)=YHAT
21     X(2,I)=RES
15     CONTINUE
       CALL SORT(YMIN,YMAX)
       IF(IUNIT.EQ.1) GO TO 59
       WRITE(6,55) ICOM
55     FORMAT("1   OPTION TAKEN",I7,/)
       GO TO 63
59     WRITE(1,84) I78
84     FORMAT(A2)
       WRITE(1,55) ICOM
63     WRITE(IUNIT,56) YMIN,YMAX
56     FORMAT(" YMIN = ",F14.7,5X,"YMAX = ",F14.7,/)
       IF(YMIN.LT.0.AND.YMAX.GT.0) GO TO 57
       IF(IUNIT.EQ.1) GO TO 65
       WRITE(6,16)
16     FORMAT(3X,"YMIN",97X,"YMAX")
       GO TO 66
65     WRITE(1,17)
17     FORMAT("YMIN",58X,"YMAX")
       GO TO 66
57     RANGE=YMAX-YMIN
       Z=-YMIN/RANGE
       IF(IUNIT.EQ.1) GO TO 67
       IV=99.*Z+.5
       IF(IV.GT.5.AND.IV.LT.98) GO TO 70
       WRITE(6,16)
       GO TO 66
70     IC(IV+3)=1H0
       WRITE(6,71) (IC(I),I=1,105)
71     FORMAT(105A1)
       IC(IV+3)=1H
       GO TO 66
67     IV=59.*Z+.5
       IF(IV.GT.5.AND.IV.LT.58) GO TO 72
       WRITE(1,17)
       GO TO 66
```

```
72    ID(IV+3)=1H0
      WRITE(1,73) (ID(I),I=1,67)
73    FORMAT(67A1)
      ID(IV+3)=1H
66    CONTINUE
      IF(IUNIT.EQ.1) WRITE(1,564)
564   FORMAT(70("_"),/)
      IF(IUNIT.EQ.6) WRITE(6,566)
566   FORMAT(110("_"))
      CALL STD(YMIN,YMAX)
      CALL PPLOT
      IF(IUNIT.EQ.1) WRITE(1,569) I77,I78
569   FORMAT(2A2)
      GO TO 2
999   WRITE(1,30)
30    FORMAT(///,"RESIDUAL ANALYSIS COMPLETE")
      CALL CLOSE(IB)
      REWIND 8
      END
      SUBROUTINE STD(XMIN,XMAX)
      COMMON IUNIT,NSUB,X(2,1000)
      RANGE=XMAX-XMIN
      DO 10 I=1,NSUB
10    X(2,I)=(X(2,I)-XMIN)/RANGE
      RETURN
      END
      SUBROUTINE PPLOT
      COMMON IUNIT,NSUB,X(2,1000)
      DIMENSION IA(100)
      DATA ISTAR/1H*/,IBLANK/1H /
      DO 10 I=1,NSUB
      DO 20 L=1,100
20    IA(L)=IBLANK
      ZK=59.
      IF(IUNIT.EQ.6) ZK=99.
      Z=X(2,I)
      J=ZK*Z + 1
      IA(J)=ISTAR
      IF(IUNIT.EQ.1) GO TO 30
      WRITE(IUNIT,1) IA
1     FORMAT(4X,"I",100A1,"I")
      GO TO 10
30    WRITE(1,2) (IA(M),M=1,60)
2     FORMAT(3X,"I",60A1,"I")
10    CONTINUE
      RETURN
      END
      SUBROUTINE SORT(YMIN,YMAX)
      COMMON IUNIT,NSUB,X(2,1000)
      YMIN=X(2,1)
      YMAX=YMIN
      DO 10 I=1,NSUB
      YMIN=AMIN1(YMIN,X(2,I))
      YMAX=AMAX1(YMAX,X(2,I))
10    CONTINUE
      N1=NSUB-1
      DO 1 I=1,N1
```

```
      J=1+I
      DO 2 K=J,NSUB
      IF(X(1,I).LE.X(1,K)) GO TO 2
      TEMP=X(1,I)
      X(1,I)=X(1,K)
      X(1,K)=TEMP
      TEMP=X(2,I)
      X(2,I)=X(2,K)
      X(2,K)=TEMP
2     CONTINUE
1     CONTINUE
      RETURN
      END
      END$
```

FATAA (Factor Analysis)

Purpose:

FATAA computes principal components of a correlation matrix and, optionally, follows with a principal factor analysis using squared multiple correlations as communality estimates. If desired, the principal factor analysis may be iterated until commonalities stabilize with n an specified tolerance.

Principal components analysis may be run alone or used as a beginning point for the factor analysis. In the factor analysis, the number of factors extracted will be equal to the number of eigenvalues from the rincipal components analysis which are greater than one, unless a smaller number is specified.

As with any analysis involving matrix inversion, care should be taken not to include variables which are completely predictable from linear combination of other variables included. In practice, variables with very high multiple correlation (.98 or above) are likely to involve inversion problems. The program will detect such linear dependencies, exclude those variables from the analysis, and repeat the analysis with the reduced matrix.

User Considerations and Procedures:

1. Program SRM30 must be run first to give FATAA initial correlation matrix, variable means, standard deviation, and variable names.

2. Program has option for calling varimax rotation program. If this option is used, before running FATAA, enter RP, VARI. After FATAA and VARI is complete enter 'OF, VARI'.

3. Program uses disc files 'SCRTCH' and 'REDMTX'. These should never be purged from disc. Also, program creates user files for other programs such as for varimax rotation. These should be treated as regular data files and should be purged (deleted) from the disc when not needed.

4. Initial options and parameters:

   a. option for device output, enter 1 for CRT output or 6 for line printer

   b. enter number of variables from SRM30 (maximum 30)

   c. enter 1 for principal component solution only, enter 0 for principal component and principal factor solutions

d. enter maximum number of factors to be extracted (maximum of 30). This should not be greater than number of variables. A zero value defaults to 30

e. enter maximum number of iterations for principal factor solutions. A zero value defaults to 1. NOTE: The more iterations requested, the longer the program takes

f. maximum number of iterations for eigenvalue extraction. A zero value defaults to 10

g. enter convergence criterion for eigenvalue extraction. A zero value defaults to .01

h. enter convergence criterion for stabilization of communalities. Iteration will stop when all communalities change less than this value across iterations. A zero value defaults to .01, which is considered stringent. For a moderately unstable solution, .03 or .05 is better

i. enter number of variables to be <u>excluded</u> from the analysis

j. enter 1 for a printout of intermediate results, otherwise enter 0. This option slows down the program and should only be used when convergence is uncertain

k. enter lowest acceptable eigenvalue (for consideration as a factor). A zero value defaults to 1.00

l. enter the numbers of variables to exclude in any order, separated by commas. (If response to option i was 0, this option does not occur)

m. name of output file for principal component solution

n. name of output file for principal factor solution, if optioned for

o. enter 1 to call varimax rotation program (VARI); else enter 0. (See (2) User Considerations and Procedures.) NOTE: After FATAA is finished, you can call VARI by hand, by entering RU, VARI. All options for varimax rotation program is given in VARI.

5. Printout gives:

a. rank of matrix, determinant, and a list of variables eliminated during inversion due to linear dependencies

b. final <u>r</u> matrix, after exclusions and eliminations

c. principal components solution

1) number of factors with eigenvalues greater than 1.0
2) total percent of variance explained by the number of factors extracted
3) estimated common variance
4) for each factor, eigenvalue and percent of variance explained
5) commonality for each variable
6) factor loading matrix

d. correlation matrix with squared multiple correlations in diagonal

e. principal factor solution

1) if iterated, commonality for each iteration and its change from preceding iteration, and factor matrix if elected by option
2) when iterations are completed, output for the principal factor solution corresponding to c-1 through c-6 above

Test Data:

This program was tested using the same data as SRM30 (See SRM30). The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to four or five digit places instead of ten digits.

```
 RP,VARI
:RU,FATAA
PRINCIPAL COMPONENTS/FACTOR ANALYSIS
NOTE:  THIS PROGRAM WILL OPEN/READ/WRITE SEVERAL DISC FILES
   'SCRATCH'; 'REDMTX'; 2 USER FILES
IT WOULD BE PRUDENT TO CHECK FOR EXISTING FILES
BEFORE RUNNING
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:
6
ENTER # OF VBS. IN MATRIX:
8
ENTER 1 FOR PRINCIPAL COMPONENTS ONLY, Ø FOR PRINCIPAL
COMPONENTS AND PRINCIPAL FACTORS:
Ø
ENTER MAX # OF FACTORS TO BE EXTRACTED (Ø DEFAULTS TO 3Ø):
8
ENTER MAX # OF ITERATIONS OF PRINCIPAL FACTOR SOLUTIONS
(Ø DEFAULTS TO 1):
25
ENTER MAX # ITERATIONS FOR EIGEN VALUE EXTRACTION
(Ø DEFAULTS TO 1Ø):
5Ø
ENTER CONVERGENCE CRITERION FOR EIGEN VALUE EXTRACTION
(Ø DEFAULTS TO .Ø1):
.ØØ5
ENTER CRITERION FOR STABILIZING COMMUNALITIES
(Ø DEFAULTS TO .Ø1):
.ØØ5
ENTER # OF VARIABLES TO BE EXCLUDED BEFORE ANALYSIS:
Ø
ENTER 1 TO PRINT INTERMEDIATE ITERATIONS, Ø OTHERWISE:
Ø
ENTER LOWEST ACCEPTABLE EIGEN VALUE
(Ø DEFAULTS TO 1.ØØ):
1
COMPUTE PRINCIPAL COMPONENTS
COMPUTE COMMUNALITY
 PRINCIPAL COMPONENTS SOLUTION OUTPUT NOW
PRINT FACTOR MATRIX
ENTER NAME OF THIS OUTPUT FILE:
OUTP1
COMPUTE INVERSE
PRINT FACTOR MATRIX
ENTER NAME OF THIS OUTPUT FILE:
OUTP2
ENTER 1 TO CALL VARIMAX
1
VARIMAX
ENTER 1 FOR CRT OUTPUT, 6 TO LPT:
6
ENTER # OF SETS OF ROTATION (MAX IS 25):
1
```

```
ROTATE WITH & W/OUT GENERAL FACTOR (1=Y, Ø=N):
Ø
ENTER #'S OF FACTORS IN EACH SET TO BE ROTATED FROM SMALLEST TO LARGEST:
3
WOULD YOU PREFER TO SKIP THE PRINCIPAL COMPONENT
 SOLUTION AND PERFORM ONLY THE PRINCIPAL AXIS SOLUTION?
(1=Y, Ø=N):
Ø
MS1, NV =     8
 ENTER NAME OF FILE CONTAINING FACTOR MATRIX FOR  PRINCIPAL COMPONENTS:
OUTP1
MS2,NFR =     3
BIG LOOP THRU NX SETS OF SEPARATE ROTATION PROBLEMS
OBTAIN RESIDUAL CORRELATIONS
 ENTER NAME OF FILE CONTAINING FACTOR MATRIX FOR PRINCIPAL AXIS SOLUTION:
OUTP2
MS2,NFR =     3
BIG LOOP THRU NS SETS OF SEPARATE ROTATION PROBLEMS
OBTAIN RESIDUAL CORRELATIONS
ENTER 1 TO CONTINUE, Ø TO END RUN:
Ø
  VARI  :  STOP    ØØØØ
Ø
  FATAA :  STOP    ØØØØ
:OF,VARI
VARI ABORTED
 :
```

NUMBER OF VARIABLES. 8
RANK OF MATRIX 8
DETERMINANT. 1946902E-03

CORRELATION MATRIX

		1	2	3	4	5	6	7	8
A	1	1.0000							
B	2	.2301	1.0000						
C	3	-.2057	.3379	1.0000					
D	4	-.2388	-.2689	.4819	1.0000				
E	5	-.2014	-.2920	.4241	.9689	1.0000			
F	6	-.2070	-.1948	.4659	.9375	.8408	1.0000		
G	7	-.3045	-.1690	.492[illegible]	.6105	.6300	.4869	1.0000	
H	8	-.3451	-.3307	.0846	.3755	.4281	.2326	.6872	1.0000

PRINCIPAL COMPONENTS SOLUTION

FACTOR EXTRACTION STATISTICS

NUMBER OF FACTORS 3
PERCENT OF VARIANCE 8230
ESTIMATED COMMON VARIANCE . 1.0000

FACTOR	EIGENVALUE	PERCENT VARIANCE	CUMULATIVE PERCENT
1	4.0257	.5032	.5032
2	1.4783	.1848	.6880
3	1.0802	.1350	.8230

COMMUNALITIES

VARIABLE		COMMUNALITY
A	1	.5316
B	2	.8506
C	3	.8531
D	4	.9852
E	5	.9308
F	6	.8982
G	7	.7763
H	8	.7583

FACTOR MATRIX

		1	2	3
A	1	.4035	.3209	-.5155
B	2	.3052	.7904	.3644
C	3	-.5507	.6546	.3484
D	4	-.9429	.1252	-.2836
E	5	-.9240	.0611	-.2708
F	6	-.8559	.2173	-.3442
G	7	-.8013	-.0678	.3600
H	8	-.5908	-.5009	.3980

CORRELATION MATRIX

		1	2	3	4	5	6	7	8
A	1	.2396							
B	2	.2301	.4440						
C	3	-.2057	.3379	.6198					
D	4	-.2388	-.2689	.4819	.9922				
E	5	-.2014	-.2920	.4241	.9689	.9798			
F	6	-.2070	-.1948	.4659	.9375	.8408	.9604		
G	7	-.3045	-.1630	.4920	.6105	.6300	.4869	.7055	
H	8	-.3451	-.3307	.0846	.3755	.4281	.2326	.6872	.6021

NOTE: DIAGONAL ENTRIES ARE SQUARED MULTIPLE CORRELATIONS OF EACH VARIABLE WITH THE OTHER N-1 VARIABLES.

FACTOR EXTRACTION STATISTICS

NUMBER OF FACTORS	3
PERCENT OF VARIANCE	.7276
ESTIMATED COMMON VARIANCE .	.7276

FACTOR	EIGENVALUE	PERCENT VARIANCE	CUMULATIVE PERCENT
1	3.8808	.4851	.4851
2	1.1342	.1418	.6269
3	.8059	.1007	.7276

COMMUNALITIES

VARIABLE		COMMUNALITY
A	1	.1605
B	2	.5957
C	3	.7442
D	4	1.0626
E	5	.8862
F	6	.8556
G	7	.8211
H	8	.6950

FACTOR MATRIX

		1	2	3
A	1	.3185	-.1727	-.1709
B	2	.2777	-.6648	.2768
C	3	-.5322	-.5910	.3343
D	4	-.9874	-.0869	-.2831
E	5	-.9205	-.0123	-.1969
F	6	-.8590	-.2269	-.3164
G	7	-.7728	.1255	.4562
H	8	-.5437	.4881	.4014

VARIABLES UNDER ANALYSIS

A	B	C	D	E	F	G	H
	OUTP1						
1 1	.4034796	.3051817	-.5507126	-.9429269	-.9239882	-.8559079	-.8012877
1 2	-.5907568						
2 1	.3209112	.7903879	.6545957	.1251977	.0610765	.2172822	-.0678236
2 2	-.5009069						
3 1	-.5155404	.3644105	.3483532	-.2836099	-.2708402	-.3441698	.3600312
3 2	.3980054						

ITER. 1 3ROTATIONS OUT OF 3 MORE THAN .01 DEGREES

ITER. 2 3ROTATIONS OUT OF 3 MORE THAN .01 DEGREES

ITER. 3 2ROTATIONS OUT OF 3 MORE THAN .01 DEGREES

ITER. 4 0ROTATIONS OUT OF 3 MORE THAN .01 DEGREES

PRINCIPAL COMPONENTS SOLUTION

KAISER VARIMAX ROTATED FACTOR MATRIX
8 VARIABLES X 3 FACTORS

VAR IDEN #		1	2	3
A	1	.035	-.007	-.728
B	2	.247	.851	-.255
C	3	-.463	.764	.234
D	4	-.968	.004	.220
E	5	-.931	-.045	.249
F	6	-.942	.048	.089
G	7	-.506	.162	.703
H	8	-.208	-.200	.822
SUM OF FACTOR LDGS SQD		3.268	1.379	1.937
PERCENT OF VARIANCE		40.852	17.236	24.214

TOTAL PERCENT OF VARIANCE OF 3 FACTORS = 82.303

RESIDUAL CORRELATION MATRIX - 3 FACTORS EXTRACTED
UPR RH-ORIGINAL CORRELATIONS
DIAGONAL=COMMUNALITY
LWR LH=RESIDUAL CORRELATIONS

VAR IDEN #		1	2	3	4	5	6	7	8
A	1	.532	.230	-.206	-.239	-.201	-.207	-.304	-.345
B	2	.041	.851	.338	-.269	-.292	-.195	-.169	-.331
C	3	-.014	-.138	.853	.482	.424	.466	.492	.085
D	4	-.045	.023	-.021	.985	.969	.938	.610	.376
E	5	.012	.040	-.030	.013	.931	.841	.630	.428
F	6	-.109	.020	-.028	.006	-.057	.898	.487	.233
G	7	.226	-.002	-.030	-.034	-.009	-.060	.776	.687
H	8	.259	.100	-.051	-.006	.021	-.027	.037	.758

OUTP2

1	1	.3185080	.2777376	-.5321764	-.9373664	-.9204900	-.8390125	-.7728373
1	2	-.5437081						
2	1	-.1727054	-.6647741	-.5909611	-.0869128	-.0122773	-.2269451	.1254906
2	2	.4881231						
3	1	-.1709202	.2767981	.3342820	-.2830939	-.1969187	-.3164412	.4561766
3	2	.4014435						

ITER. 1 3 ROTATIONS OUT OF 3 MORE THAN .01 DEGREES

ITER. 2 3 ROTATIONS OUT OF 3 MORE THAN .01 DEGREES

ITER. 3 2 ROTATIONS OUT OF 3 MORE THAN .01 DEGREES

ITER. 4 0 ROTATIONS OUT OF 3 MORE THAN .01 DEGREES

PRINCIPAL AXIS SOLUTION

KAISER VARIMAX ROTATED FACTOR MATRIX

8 VARIABLES X 3 FACTORS

VAR	IDENT #	1	2	3
A	1	.133	-.034	-.376
B	2	.204	-.690	-.280
C	3	-.417	-.713	.248
D	4	-.980	.008	.319
E	5	-.863	.031	.376
F	6	-.909	-.082	.147
G	7	-.376	-.188	.803
H	8	-.124	.164	.808

SUM OF FACTOR LDGS SQD	2.922	1.055	1.844
PERCENT OF VARIANCE	36.523	13.192	23.046

TOTAL PERCENT OF VARIANCE OF 3 FACTORS = 72.762

RESIDUAL CORRELATION MATRIX - 3 FACTORS EXTRACTED
UPR RH-ORIGINAL CORRELATIONS
DIAGONAL=COMMUNALITY
LWR LH=RESIDUAL CORRELATIONS

VAR	IDEN #	1	2	3	4	5	6	7	8
A	1	.160	.230	-.206	-.239	-.201	-.207	-.304	-.345
B	2	.074	.596	.338	-.269	-.292	-.195	-.169	-.331
C	3	-.081	.000	.744	.482	.424	.466	.492	.085
D	4	.012	.026	-.000	1.063	.969	.938	.610	.376
E	5	.056	.010	-.007	.003	.886	.841	.630	.428
F	6	-.033	-.025	-.009	-.000	.003	.656	.487	.233
G	7	.041	.003	.002	-.013	.010	.011	.821	.687
H	8	-.019	.034	-.050	-.005	.013	.014	.023	.695

```
*FATAA T=00004 IS ON CR00002 USING 00062 BLKS R=0492

FTN4
      PROGRAM FATAA
      INTEGER XID
      DIMENSION X(30),COM(30),Y(30),INFILE(3),IFMT(20),IOFILE(3)
      DIMENSION ISIZE(2)
      COMMON NELVA(30),XID(30,4),NEX
      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
      DIMENSION IB(272),IBUF(256),IDA(3),IRDX(3),ISCR(3),NVARI(3)
      DATA NVARI/2HVA,2HRI,2H  /
      DATA ISCR/2HSC,2HRT,2HCH/
      DATA IRDX/2HRE,2HDM,2HTX/
      DATA IDA/2HSR,2HDA,2HTA/
      WRITE(1,4400)
4400  FORMAT ( "PRINCIPAL COMPONENTS/FACTOR ANALYSIS" )
      WRITE(1,4401)
4401  FORMAT("NOTE: THIS PROGRAM WILL OPEN/READ/WRITE SEVERAL DISK ",
     $"FILES")
      WRITE(1,4402)
4402  FORMAT ( "  'SCRATCH'; 'REDMTX'; 2 USER FILES"  )
      WRITE(1,4403)
4403  FORMAT ( "IT WOULD BE PRUDENT TO CHECK FOR EXISTING FILES"  )
      WRITE(1,4404)
4404  FORMAT ( "BEFORE RUNNING" )
      WRITE(1,4405)
4405  FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:  ")
      READ(1,*) IUNIT
1500  WRITE(1,4406)
4406  FORMAT ( "ENTER # OF VBS. IN MATRIX: ")
      READ(1,*)  NV
      WRITE(1,4407)
4407  FORMAT("ENTER 1 FOR PRINCIPAL COMPONENTS ONLY,0 FOR PRINCIPAL")
      WRITE(1,4408)
4408  FORMAT ( "COMPONENTS AND PRINCIPAL FACTORS:  ")
      READ(1,*) NTYP
      WRITE(1,4409)
4409  FORMAT( "ENTER MAX # OF FACTORS TO BE EXTRACTED (0 DEFAULTS ",
     X"TO 30):")
      READ(1,*) MAXFAC
      WRITE(1,4410)
4410  FORMAT("ENTER MAX # OF ITERATIONS OF PRINCIPAL FACTOR ",
     C"SOLUTIONS")
      WRITE(1,4411)
4411  FORMAT ( "(0 DEFAULTS TO 1): ")
      READ(1,*) MAXIT
      WRITE(1,4412)
4412  FORMAT ( "ENTER MAX # ITERATIONS FOR EIGENVALUE EXTRACTION "  )
      WRITE(1,4413)
4413  FORMAT ( "(0 DEFAULTS TO 10):  ")
      READ(1,*) ITMAX
      WRITE(1,4414)
```

```
4414  FORMAT("ENTER CONVERGENCE CRITERION FOR EIGENVALUE EXTRACTION")
      WRITE(1,4415)
4415  FORMAT ( "(0 DEFAULTS TO .01): ")
      READ(1,*)  EPS
      WRITE(1,4416)
4416  FORMAT ( "ENTER CRITERION FOR STABILIZING COMMUNALITIES " )
      WRITE(1,4417)
4417  FORMAT ( "(0 DEFAULTS TO .01): ")
      READ(1,*)  CRIT
      WRITE(1,4418)
4418  FORMAT("ENTER # OF VARIABLES TO BE EXCLUDED BEFORE ANALYSIS: ")
      READ(1,*)  NEX
      WRITE(1,4419)
4419  FORMAT("ENTER 1 TO PRINT INTERMEDIATE ITERATIONS,0 OTHERWISE:")
      READ(1,*)  IGEN
      WRITE(1,4420)
4420  FORMAT ( "ENTER LOWEST ACCEPTABLE EIGENVALUE "  )
      WRITE(1,4421)
4421  FORMAT ( "(0 DEFAULTS TO 1.00):  ")
      READ(1,*) AYGN
      IF(MAXFAC.EQ.0)MAXFAC=30
      IF(MAXIT.EQ.0)MAXIT=1
      IF(ITMAX.EQ.0)ITMAX=10
      IF(EPS.EQ.0)EPS=.01
      IF(CRIT.EQ.0)CRIT=.01
      IF(AYGN.EQ.0)AYGN=1.00
      IF(NEX.EQ.0)GO TO 1492
      WRITE(1,4422)
4422  FORMAT ( "ENTER #'S OF VBS TO EXCLUDE, ANY ORDER:  ")
      READ(1,*) (NELVA(I),I=1,NEX)
1492  CONTINUE
      IPUN=0
74    CALL OPEN(IB,IER,IDA,3,0,-2,256)
      IF(IER.GE.0)GO TO 745
      WRITE(1,4428) IER
4428  FORMAT ( "SRDATA FILE FAILED TO OPEN, IER = ",I5 )
      STOP
745   DO 10 I=1,30
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,94) (R(J,I),J=1,30)
10    CONTINUE
94    FORMAT(30(2X,F10.4))
      CALL READF(IB,IER,IBUF,256,LEN,61)
      CALL CODE
      READ(IBUF,94) X
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,94) COM
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,808) ((XID(I,J),J=1,4),I=1,30)
808   FORMAT(30(4X,4A2)
      CALL CLOSE(IB)
      CALL OPEN(IB,IER,ISCR,3,0,-2,256)
      IF(NEX.NE.0)CALL REDC(NV,0)
251   DO 252 I=1,30
```

```
      CALL CODE
      WRITE(IBUF,747)(R(I,J),J=1,30)
747   FORMAT(30(2X,F12.5))
252   CALL WRITF(IB,IER,IBUF)
253   CONTINUE
      CALL CLOSE(IB,IER)
      WRITE(IUNIT,1894)NV
1894  FORMAT(//5X,"NUMBER OF VARIABLES......",2X,I2)
      DETER=SIML(NV)
      IF(NEX.NE.0)CALL REDC(NV,1)
      WRITE(IUNIT,1895)NV,DETER
1895  FORMAT(5X,"RANK OF MATRIX...........",2X,I2/5X,
     X"DETERMINANT..............",2X,E14.7)
      IF(NEX.EQ.0)GO TO 2600
1896  FORMAT(5X,"VARIABLES ELIMINATED.....",2X,I3)
      WRITE(IUNIT,1896)NEX
      DO 1897  I=1,NEX
      KP=NELVA(I)
1897  WRITE(IUNIT,1898)(XID(KP,J),J=1,4)
1898  FORMAT(32X,4A2)
2600  DO 80 I=1,NV
80    X(I)=1.0-(1.0/R(I,I))
      NV=NV+NEX
      CALL OPEN(IB,IER,ISCR,3,0,-2,256)
      DO 2602 I=1,30
      CALL READF(IB,IER,IBUF)
      CALL CODE
2602  READ(IBUF,747)(R(I,J),J=1,30)
      CALL CLOSE(IBUF,IER)
      IF(NEX.EQ.0)GO TO 2345
      CALL REDC(NV,0)
      CALL OPEN(IB,IER,ISCR,3,0,-2,256)
      DO 38 I=1,30
      CALL CODE
38    WRITE(IBUF,747)(R(I,J),J=1,30)
      CALL CLOSE(IB,IER)
      WRITE(1,4429)
4429  FORMAT ( "PRINT R MATRIX" )
2345  CALL RPRT(1,NV)
      CALL OPEN(IB,IER,IRDX,3,0,-2,256)
      IF(IER.GE.0)GO TO 2344
      WRITE(1,4430) IER
4430  FORMAT ( "REDMTX FILE FAILED TO OPEN, IER = ",I5 )
      STOP
2344  CALL CODE
      WRITE(IBUF,2093)NV
      CALL WRITF(IB,IER,IBUF)
      DO 2346 I=1,30
      CALL CODE
      WRITE(IBUF,747)(R(I,J),J=1,30)
2346  CALL WRITF(IB,IER,IBUF)
2347  CALL CODE
      WRITE(IBUF,808)((XID(I,J),J=1,4),I=1,30)
      CALL WRITF(IB,IER,IBUF)
      CALL CLOSE (IB,IER)
      IF(NTYP.EQ.2)GO TO 4300
      WRITE(1,4431)
4431  FORMAT ( "COMPUTE PRINCIPLE COMPONENTS" )
```

```
      CALL EXTC(NV,ITMAX,EPS,IGEN,PCT)
      TVAR=0.0
      DO 120 J=1 NV
      IF(EIGEN(J).LT.AYGN)GO TO 135
      TVAR=TVAR+VAR(J)
      IF(J.EQ.MAXFAC)GO TO 130
120   CONTINUE
130   NFAC=J
      GO TO 140
135   NFAC=J-1
      WRITE(1,4432)
4432  FORMAT ( "COMPUTE COMMUNALITY"  )
140   DO 150 I=1,NV
      COM(I)=0
      DO 150 J=1,NFAC
      T(I,J)=T(I,J)*SQRT(EIGEN(J))
150   COM(I)=COM(I)+T(I,J)*T(I,J)
      IF(IUNIT.EQ.6) WRITE(1,4090)
4090  FORMAT(" PRINCIPAL COMPONENTS SOLUTION OUTPUT NOW ")
      WRITE(IUNIT,303)
303   FORMAT("    PRINCIPAL COMPONENTS SOLUTION")
      GO TO 200
2001  CALL OPEN(IB,IER,ISCR,3,0,-2,256)
      WRITE(1,4433)
4433  FORMAT ( "COMPUTE INVERSE"  )
2003  DO 2004 I=1,30
      CALL READF(IB,IER,IBUF)
      CALL CODE
2004  READ(IBUF,747)(R(I,J),J=1,30)
2005  CONTINUE
      CALL CLOSE(IB,IER)
      NTYP=NTYP+1
      DO 90 I=1,NV
90    R(I,I)=X(I)
      CALL RPRT (0,NV)
      ITER=0
1609  CALL EXTC(NV,ITMAX,EPS,IGEN,PCT)
      ITER=ITER+1
      TVAR=0
      DO 2250 I=1,NFAC
2250  TVAR=TVAR+VAR(I)
      DO 2150 I=1,NV
      COM(I)=0
      DO 2150 J=1,NFAC
      T(I,J)=T(I,J)*SQRT(EIGEN(J))
2150  COM(I)=COM(I)+T(I,J)*T(I,J)
      IF(IGEN.EQ.0) GO TO 1305
      WRITE(IUNIT,506)ITER,(J,X(J),COM(J),J=1,NV)
506   FORMAT(///,5X,"ITERATION  ",I3//10X,
     X"VARIABLE     ESTIMATED     OBSERVED"//
     $(13X,I3,2X,F10.4,2X,F10.4))
      CALL FPRT(NV,NFAC)
1305  IF(ITER.EQ.MAXIT)GO TO 199
      DO 160 J=1,NV
      IF(ABS(COM(J)-X(J)).GT.CRIT)GO TO 180
160   CONTINUE
```

```
      GO TO 200
180   DO 185 J=1,NV
185   X(J)=COM(J)
      CALL OPEN(IB,IER,ISCR,3,0,-2,256)
1841  DO 1842 I=1,30
      CALL READF(IB,IER,IBUF)
      CALL CODE
1842  READ(IBUF,747)(R(I,J),J=1,30)
1843  CONTINUE
      CALL CLOSE(IB,IER)
      DO 186 I=1,NV
186   R(I,I)=X(I)
      GO TO 1809
199   CONTINUE
      IF(IUNIT.EQ.6) WRITE(1,413)
413   FORMAT("PRINCIPAL FACTORS SOLUTION OUTPUT NOW ")
      WRITE(IUNIT,302)
302   FORMAT("     PRINCIPAL FACTOR SOLUTION")
200   Y(1)=VAR(1)
      DO 205 J=2,NFAC
      JM1=J-1
205   Y(J)=Y(JM1)+VAR(J)
      WRITE(IUNIT,206) NFAC,TVAR,PCT
206   FORMAT(//" FACTOR EXTRACTION STATISTICS"//10X
     1"NUMBER OF FACTORS........",5X,I5/10X,
     2"PERCENT OF VARIANCE......",F10.4/10X,
     3"ESTIMATED COMMON VARIANCE",F10.4///
     415X,"FACTOR",4X,"EIGENVALUE",4X,"PERCENT VARIANCE",4X,
     5"CUMULATIVE PERCENT"//)
      WRITE(IUNIT,207)(J,EIGEN(J),VAR(J),Y(J),J=1,NFAC)
207   FORMAT(17X,I2,4X,F10.4,6X,F10.4,11X,F10.4)
      WRITE(IUNIT,209) ((XID(I,J),J=1,4),I,COM(I),I=1,NV)
209   FORMAT(4X,"COMMUNALITIES"//" VARIABLE",13X," COMMUNALITY"
     1/(5X,4A2,5X,I3,F10.4))
      WRITE(1,4435)
4435  FORMAT ( "PRINT FACTOR MATRIX"  )
      CALL FPRT(NV,NFAC)
      WRITE(1,4436)
4436  FORMAT ( "&ENTER NAME OF THIS OUTPUT FILE:" )
      READ(1,809)IOFILE
809   FORMAT(3A2)
      ISIZE(1)=63
      ISIZE(2)=53
      CALL CREAT(IB,IER,IOFILE,ISIZE,2,0,-2,144)
      IF(IER.GE.0)GO TO 2094
      WRITE(1,4437) IER
4437  FORMAT ( "OUTPUT FILE FAILED TO OPEN, IER = ",I5 )
      STOP
2093  FORMAT(5X,I5)
2094  CALL CODE
      WRITE(IBUF,2093)NFAC
      CALL WRITF(IB,IER,IBUF)
      DO 210 J=1,NFAC
      M=0
      DO 210 K=1,NV,7
```

```
      L=MINO(K+ 6,NV)
      M=M+1
      CALL CODE
      WRITE(IBUF,2095) J,M,(T(I,J),I=K,L)
210   CALL WRITF(IB,IER,IBUF)
2095  FORMAT(2I3,2X,10F10.7)
      CALL LOCF(IB,IER,I1,IRB,I1,JSFC)
      ITRUN=JSFC/2 - IRB - 1
      CALL CLOSE(IB,IER,ITRUN)
      IF(NTYP.EQ.0)GO TO 2001
      WRITE(1,4438)
4438  FORMAT ( "ENTER 1 TO CALL VARIMAX  ")
      READ(1,*) VARI
      IF(VARI.EQ.1)CALL EXEC(9,NVARI)
4300  WRITE(1,4439)
4439  FORMAT ( "ENTER 1 TO CONTINUE, 0 TO END RUN: ")
      READ(1,*)  NEXT
      CALL CLOSE(IB,IER)
      IF(NEXT.NE.0)GO TO 1500
3300  STOP
      END
      SUBROUTINE FPRT(NV,NFAC)
      INTEGER XID
      COMMON NELVA(30),XID(30,4),NEX
      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
      WRITE(IUNIT,1803)
1803  FORMAT(4X,"FACTOR MATRIX")
      DO 640 K=1,NFAC,8
      L=MINO(K+7,NFAC)
      WRITE(IUNIT,460)(J,J=K,L)
460   FORMAT(//12X,8(8X,I3))
      DO 640 I=1,NV
640   WRITE(IUNIT,385)(XID(I,J),J=1,4),I,(T(I,J),J=K,L)
385   FORMAT(1X,4A2,2X,I3,3X,8(F7.4,4X))
      RETURN
      END
      SUBROUTINE RPRT(NTYP,NV)
      INTEGER XID
      COMMON NELVA(30),XID(30,4),NEX
      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
      WRITE(IUNIT,355)
355   FORMAT(//5X"CORRELATION MATRIX")
400   DO 440 K=1,NV,8
      L=MINO(K+7,NV)
      WRITE(IUNIT,460)(J,J=K,L)
460   FORMAT(//12X,8(8X,I3))
      DO 440 I=K,NV
      MD=MINO(L,I)
440   WRITE(IUNIT,385)(XID(I,J),J=1,4),I,(R(I,J),J=K,MD)
385   FORMAT(1X,4A2,2X,I3,3X,8(F7.4,4X))
      IF(NTYP.NE.1)WRITE(IUNIT,407)
407   FORMAT(//5X,"NOTE--DIAGONAL ENTRIES ARE SQUARED MULTIPLE
     $CORRELATIONS OF EACH VARIABLE WITH THE OTHER N-1 VARIABLES")
      RETURN
      END
```

```
      SUBROUTINE EXTC(NV,ITMAX,EPS,IGEN,PCT)
      DIMENSION AIK(30)
      INTEGER XID
      COMMON NELVA(30),XID(30,4),NEX
      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
      EQUIVALENCE (VAR,AIK)
      DO 2 I=1,NV
      DO 2 J=1,NV
2     T(I,J)=0
      SIG1=0
      OFFDSQ=0
      DO 5 I=1,NV
      SIG1=SIG1+R(I,I)
      T(I,I)=1
      II=I+1
      IF(I.GE.NV)GO TO 6
      DO 5 J=II,NV
5     OFFDSQ=OFFDSQ+R(I,J)*R(I,J)
6     S=2*OFFDSQ+SIG1
      SIG1D=SIG1
      NVV=NV-1
      PCT=SIG1D/NV
      DO 26 ITER=1,ITMAX
      DO 20 I=1,NVV
      II=I+1
      DO 20 J=II,NV
      Q=ABS(R(I,I)-R(J,J))
      IF(Q.LE.1.E-7)GO TO 9
      IF(ABS(R(I,J)).LE.1.E-7)GO TO 20
      P=2*R(I,J)*Q/(R(I,I)-R(J,J))
      SPQ=SQRT(P*P+Q*Q)
      CSA=SQRT((1+Q/SPQ)/2)
      SNA=P/(2*CSA*SPQ)
      GO TO 10
9     CSA=1/SQRT(2.0)
      SNA=CSA
10    CONTINUE
      DO 11 K=1,NV
      WT=T(K,I)
      T(K,I)=WT*CSA+T(K,J)*SNA
11    T(K,J)=WT*SNA-T(K,J)*CSA
      DO 16 K=1,NV
      IF(K.GT.J)GO TO 15
      AIK(K)=R(I,K)
      R(I,K)=CSA*AIK(K)+SNA*R(K,J)
      IF(K.NE.J)GO TO 14
      R(J,K)=SNA*AIK(K)-CSA*R(J,K)
14    GO TO 16
15    WT=R(I,K)
      R(I,K)=CSA*WT+SNA*R(J,K)
      R(J,K)=SNA*WT-CSA*R(J,K)
16    CONTINUE
      AIK(J)=SNA*AIK(I)-CSA*AIK(J)
      DO 19 K=1,J
      IF(K.LE.I)GO TO 18
      R(K,J)=SNA*AIK(K)-CSA*R(K,J)
```

```
      GO TO 19
18    WT=R(K,I)
      R(K,I)=CSA*WT+SNA *R(K,J)
      R(K,J)=SNA*WT-CSA*R(K,J)
19    CONTINUE
20    R(I,J)=0
      SIG2=0
      DO 21 I=1,NV
      EIGEN(I)=R(I,I)
21    SIG2=SIG2+EIGEN(I)*EIGEN(I)
      IF(1-SIG1/SIG2.GE.EPS)GO TO 26
      GO TO 30
26    SIG1=SIG2
30    NVV=NV-1
      DO 300 I=1,NVV
      IP1=I+1
      DO 300 J=IP1,NV
      IF(EIGEN(I).GE.EIGEN(J))GO TO 300
      TEMP=EIGEN(I)
      EIGEN(I)=EIGEN(J)
      EIGEN(J)=TEMP
      DO 250 L=1,NV
      AIK(L)=T(L,I)
      T(L,I)=T(L,J)
250   T(L,J)=AIK(L)
300   CONTINUE
      DO 35 J=1,NV
35    AIK(J)=EIGEN(J)/NV
      IF(IGEN.EQ.0)RETURN
      WRITE(IUNIT,204)
204   FORMAT("1",4X,"COMPLETE EIGENSTRUCTURE"//)
      DO 205 I=1,NV
205   WRITE(IUNIT,201)I,EIGEN(I),AIK(I)
201   FORMAT(5X,I3,2F10.4)
      RETURN
      END
      SUBROUTINE REDC(NV,NTYP)
      INTEGER XID
      COMMON NELVA(30),XID(30,4),NEX
      COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
      DIMENSION AIK(30)
      EQUIVALENCE (AIK,VAR)
      WRITE(1,4400)
4400  FORMAT ( "ORDER VARIABLES TO BE ELIMINATED" )
      IF(NEX.EQ.1)GO TO 40
      NX=NEX-1
      DO 300 I=1,NX
      IP1=I+1
      DO 300 J=IP1,NEX
      IF(NELVA(I).GE.NELVA(J))GO TO 300
      NTEMP=NELVA(I)
      NELVA(I)=NELVA(J)
      NELVA(J)=NTEMP
300   CONTINUE
```

```
40    DO 20 I=1,NEX
      MZ=NV-1
      NEL=NELVA(I)
      IF(NEL.EQ.NV)GO TO 19
      DO 15 J=NEL,MZ
      JP1=J+1
      DO 15 K=1,NV
15    R(K,J)=R(K,JP1)
      DO 17 K=NEL,MZ
      KP1=K+1
      DO 17 J=1,NV
17    R(K,J)=R(KP1,J)
      WRITE(1,4401)
4401  FORMAT ( "REDUCE VARIABLE NAMES"   )
      IF(NTYP.EQ.1)GO TO 19
      DO 18 J=NEL,MZ
      JP1=J+1
      DO 18 K=1,4
18    XID(J,K)=XID(JP1,K)
19    NV=NV-1
20    CONTINUE
      RETURN
      END
      FUNCTION SIML(M)
      INTEGER XID
      COMMON NELVA(30),XID(30,4),NEX
      COMMON R(30,30),EIGEN(30),VAR(30),IUNIT
      EQUIVALENCE (A,R)
      DIMENSION A(30,30)
      NEX=0
      DET=1
      DO 1 J=1,M
      PVT=A(J,J)
      IF(PVT.GT.0.01)GO TO 25
      NEX=NEX+1
      NELVA(NEX)=J
      GO  TO 1
25    DET=DET*PVT
      A(J,J)=1
      DO 2 K=1,M
2     A(J,K)=A(J,K)/PVT
      DO 1 K=1,M
      IF(K-J)3,1,3
3     T=A(K,J)
      A(K,J)=0
      DO 4 L =1,M
4     A(K,L)=A(K,L)-A(J,L)*T
1     CONTINUE
      SIML=DET
26    RETURN
      END
      END$
```

VARI (Varimax Location)

Purpose:

VARI accepts input from factor analysis programs and performs normalized varimax rotation on the full factor matrix or sets of the factors.

VARI offers several ways to vary the number of factors rotated. Since it is often not desirable to rotate all the factor obtained in a factor analysis, the user can choose to rotate any number of factors up to the maximum extracted. In addition, sets of various sizes can be rotated in one program run.

Another option allows the first factor to be treated as a general and ignored in rotation. If the first factor is truly a general, so that all variables load on it, the varimax procedures will not be able to achieve a satisfactory "simple structure" solution. If a general is suspected, each factor set can be rotated with and without the first factor to determine differences between the solutions. Factors are rotated pairwise until each rotation required is less than .01 degrees. Each angle of rotation is selected so as to maximize the variance of the loadings squared for each factor. This program can be run apart from FATAA with the 'RU, VARI' command or as an option of FATAA.

Initial Options and Parameters:

1. Option for device output; enter 1 for CRT display or 6 for line printer.

2. Enter number of sets of rotation (maximum is 25, 0 is set to 1). If different number of factors from the same analysis are to be rotated, this number is equal to the total of all such sets (NS).

3. Enter 1 to rotate each set twice, with and without general factor; otherwise, enter 0.

4. Enter the number of factors in each set to be rotated from smallest to largest separated by commas. (NOTE: The first set should have the smallest number of factors, the last should be largest.) If only 1 set, enter number of factors to be rotated in that set.

5. Enter 1 to skip principal component solution and perform only principal axes solution; otherwise, enter 0.

6. If asked for, enter name of file containing factor matrix for principal components solution (from FATAA).

7. Enter name of file containing factor matrix for principal axis solution (from FATAA).

8. Enter 1 to restart program, 0 to stop.

Printout Gives:

1. Number of variables and names (in number of factors principal axis solution).

2. Factor matrix from FATAA.

3. For each set of rotations:

   a. during solution, the iteration number and the number of rotations greater than 0.01 degree

   b. when rotation complete

      1) number of variables
      2) number of factors
      3) rotated factor matrix
      4) sum of factor loading squared (for each factor)
      5) percent of variance (for each factor)
      6) total percent of variance
      7) NV x NV matrix with original correlations above the diagonal, commonalities in the diagonal, and residual correlation below the diagonal

Test Data:

This program was tested using the same data as SRM30 (See SRM30). Printout of input parameters and statistical output is presented in the factor analysis calculations (See FATAA). The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to four or five digit places instead of ten digits.

```
*VARI  T=00004 IS ON CR00002 USING 00032 BLKS R=0263

FTN4
            PROGRAM VARI
            INTEGER VID
            DIMENSION IPFILE(3),IRMX(3),IB(272),IBUF(256)
            COMMON R(30,30),H(30),VID(30,4),F(30,10),
           XAIJ(30,10),NI(25),NOM(48)
            COMMON NV,NF,CON,MX,FN
            DATA IRMX/2HRE,2HDM,2HTX/
      1895  FORMAT(" PRINCIPAL COMPONENTS SOLUTION")
      1896  FORMAT(" PRINCIPAL AXIS SOLUTION")
      505   FORMAT(" ITER.",I3,I5,"ROTATIONS OUT OF ",I5," MORE THAN
           $       .01 DEGREES"/)
      507   FORMAT(41X," KAISER VARIMAX ROTATED FACTOR MATRIX"/
           $46X,I3,"VARIABLES X",I3"FACTORS "/)
      508   FORMAT(48X," FACTOR 1 - GENERAL FACTOR"/)
      509   FORMAT(/" VAR IDEN #",2X,I3,13(4X,I3))
      510   FORMAT(1X)
      511   FORMAT(1X,4A2,I4,14F7.3)
      512   FORMAT(/" SUM OF FACTOR LDGS SQD",14F7.3)
      513   FORMAT(" PERCENT OF VARIANCE ",14F7.3)
      514   FORMAT(/" TOTAL PERCENT OF VARIANCE OF ",I3," FACTORS = ",F7.3)
      515   FORMAT("1")
      516   FORMAT(34X," RESIDUAL CORRELATION MATRIX -",I3," FACTORS ",
           $"EXTRACTED",/
           $34X," UPR RH-ORIGINAL CORRELATIONS"/34X," DIAGONAL=COMMUNALITY"
           $/34X," LWR LH=RESIDUAL CORRELATIONS"/)
      517   FORMAT(" ERROR",I3," DOES NOT EQUAL ",I3," MINUS ",I3)
            WRITE(1,4400)
      4400  FORMAT ( "VARIMAX"  )
            WRITE(1,4401)
      4401  FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FO LPT:  ")
            READ(1,*) IUNIT
            CON=57.295645
      1     WRITE(1,4402)
      4402  FORMAT (  "ENTER # OF SETS OF ROTATION (MAX IS 25):  ")
            READ(1,*) NS
            WRITE(1,4403)
      4403  FORMAT ( "ROTATE WITH & W/OUT GENERAL FACTOR (1=Y, 0=N): ")
            READ(1,*)  KGEN
            WRITE(1,4404)
      4404  FORMAT( "ENTER #'S OF FACTORS IN EACH SET TO BE ROTATED",
           $"FROM SMALLEST TO LARGEST:")
            READ(1,*) (NI(I),I=1,NS)
      14    WRITE(1,4405)
      4405  FORMAT ( "WOULD YOU PREFER TO SKIP THE PRINCIPAL COMPONENT "  )
            WRITE(1,4406)
      4406  FORMAT(" SOLUTION AND PERFORM ONLY THE PRINCIPAL AXIS "
           C,"SOLUTION?")
            WRITE(1,4407)
      4407  FORMAT ( "(1=Y, 0=N):  ")
```

```
      READ(1,*) JACK
      CALL OPEN(IB,IER,IRMX,3,0,-2,256)
      IF(IER.GE.0)GO TO 1500
      WRITE(1,4408) IER
4408  FORMAT ( "REDMTX FILE FAILED TO OPEN, IER = ",I5 )
      STOP
1500  CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,1501)NV
1501  FORMAT(5X,I5)
      WRITE(1,4409) NV
4409  FORMAT ( "MS1, NV = ",I5   )
      DO 1503 I=1,30
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,1502)(R(I,J),J=1,30)
1502  FORMAT(30(2X,F12.5))
1503  CONTINUE
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,1504)((VID(I,J),J=1,4),I=1,30)
1504  FORMAT(30(4X,4A2))
      CALL CLOSE(IB,IER)
9999  FORMAT(3(2X,10F10.7/))
      WRITE(IUNIT,9996)
9996  FORMAT(/5X,"VARIABLES UNDER ANALYSIS")
C     WRITE(IUNIT,9999) ((R(I,J), J=1,30), I=1,30)
      WRITE(IUNIT,1504) ((VID(I,J), J=1,4), I=1,NV)
1545  IF(JACK.EQ.0)WRITE (1,432)
432   FORMAT(" ENTER NAME OF FILE CONTAINING FACTOR MATRIX,",
     $"FOR PRINCIPAL COMPONENTS SOLUTION:")
      IF(JACK.EQ.1) WRITE(1,433)
433   FORMAT(" ENTER NAME OF FILE CONTAINING FACTOR MATRIX ",
     $"FOR PRINCIPAL AXIS SOLUTION:")
      READ(1,1505)IPFILE
1505  FORMAT(3A2)
      CALL OPEN(IB,IER,IPFILE,3,0,-2,144)
      IF(IER.GE.0)GO TO 15055
      WRITE(1,4410) IER
4410  FORMAT ( "FACTOR MATRIX FILE FAILED TO OPEN, IER = ",I5   )
      STOP
15055 CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,1511)NFR
1511  FORMAT(5X,I5)
      WRITE(1,4411) NFR
4411  FORMAT ( "MS2,NFR = ",I5 )
      WRITE(IUNIT,9997)IPFILE
9997  FORMAT(/11X,3A2//)
      DO 1506 J=1, NFR
      M=0
      DO 1506 K=1,NV,7
      L=MIN0(K+6,NV)
      M=M+1
      CALL READF(IB,IER,IBUF)
      CALL CODE
```

```
      READ(IBUF,2095) IZ1,IZ2,(AIJ(I,J),I=K,L)
2095  FORMAT(2I3,2X,10F10.7)
1506  CONTINUE
      CALL CLOSE(IB,IER)
15075 IGEN=KGEN
      FN=NV
      IF(NS.EQ.0)NI(1)=NFR
      IF(NS.EQ.0)NS=1
      JACK=JACK+1
      JG=1
      IF(IGEN.NE.0)JG=2
      WRITE(1,4413)
4413  FORMAT ("BIG LOOP THRU NS SETS OF SEPARATE ROTATION PROBLEMS")
10    DO 100 L=1,NS
      NIT=0
      IF(L.EQ.1)KA=1
      IF(L.NE.1)KA=NI(L-1)+1
      NF=NI(L)
      DO 8 J=KA,NF
      DO 8 I=1,NV
8     F(I,J)=AIJ(I,J)
      IF(IGEN.EQ.0)M=NF*(NF-1)/2
      IF(IGEN.NE.0)M=(NF-1)*(NF-2)/2
      LK=0
      DO 9 I=1,NV
      H(I)=0
      DO 13 J=JG,NF
13    H(I)=H(I)+F(I,J)**2
      H(I)=SQRT(H(I))
      DO 9 J=JG,NF
9     F(I,J)=F(I,J)/H(I)
20    MX=M
      J=NF
11    LF=J-1
      DO 12 K=JG,LF
12    CALL CROT(J,K)
      J=J-1
      IF(J.GT.JG)GO TO 11
      NIT=NIT+1
      WRITE(IUNIT,505)NIT,MX,M
      IF(MX.GT.0)GO TO 20
      DO 30 I=1,NV
      DO 30 J=JG,NF
30    F(I,J)=F(I,J)*H(I)
      KA=1
      KB=14
      IF(NF.LT.15)KB=NF
40    IF(JACK.EQ.1)WRITE(IUNIT,1895)
      IF(JACK.EQ.2)WRITE(IUNIT,1896)
      WRITE(IUNIT,507)NV,NF
      IF(IGEN.NE.0)WRITE(IUNIT,508)
60    WRITE(IUNIT,509)(J,J=KA,KB)
      WRITE(IUNIT,510)
      DO 41 I=1,NV
```

```
      IF(LK.EQ.0)WRITE(IUNIT,511)(VID(I,J),J=1,4),I,(F(I,J),J=KA,KB)
      IF(LK.NE.0)WRITE(IUNIT,511)(VID(I,J),J=1,4),I,(R(I,J),J=KA,KB)
41    CONTINUE
      IF(LK.NE.0)GO TO 44
      DO 42 J=1,NF
      H(J)=0
      DO 42 I=1,NV
42    H(J)=H(J)+F(I,J)**2
      WRITE(IUNIT,512)(H(J),J=KA,KB)
      SUM=0
      DO 43 J=1,NF
      H(J)=100*H(J)/FN
43    SUM=SUM+H(J)
      WRITE(IUNIT,513)(H(J),J=KA,KB)
      WRITE(IUNIT,514)NF,SUM
44    KA=KA+14
      KB=KB+14
      IF(LK.NE.0)GO TO 55
      IF(KB.GE.NF)KB=NF
      IF(NF.GE.KA)GO TO 40
      WRITE(IUNIT,515)
      IF(IVGEN.NE.0)GO TO 100
      WRITE(1,4414)
4414  FORMAT ( "OBTAIN RESIDUAL CORRELATIONS" )
      DO 52 J=1,NV
      DO 52 I=J,NV
      SUM=0
      DO 51 K=1,NF
51    SUM=SUM+F(I,K)*F(J,K)
      IF(I.NE.J)GO TO 53
      R(I,I)=SUM
      GO TO 52
53    R(I,J)=R(J,I)-SUM
52    CONTINUE
      KA=1
      KB=14
      IF(NV.LT.15)KB=NV
      LK=1
50    WRITE(IUNIT,516)NF
      GO TO 60
55    IF(KB.GE.NV)KB=NV
      IF(NV.GE.KA)GO TO 50
      WRITE(IUNIT,515)
100   CONTINUE
      IF(IGEN.EQ.0)GO TO 200
      IGEN=0
      JG=1
      GO TO 10
999   WRITE(IUNIT,517)NV,NVC,NE
200   IF(JACK.EQ.1)GO TO 1545
      WRITE(1,4415)
4415  FORMAT ( "ENTER 1 TO CONTINUE, 0 TO END RUN: " )
      READ(1,*)  ICOM
      IF(ICOM.EQ.1) GO TO 1
      STOP
      END
```

```
      SUBROUTINE CROT(J,K)
      INTEGER VID
      COMMON R(30,30),H(30),VID(30,4),F(30,10),
     XAID(30,10),NI(25),NOM(48)
      COMMON NV,NF,CON,MX,FN
      A=0
      B=0
      C=0
      D=0
      DO 5 I=1,NV
      U=(F(I,J)+F(I,K))*(F(I,J)-F(I,K))
      V=2.*F(I,J)*F(I,K)
      A=A+U
      B=B+V
      C=C+(U*U-V*V)
    5 D=D+2.*U*V
      V=D-(2.*A*B)/FN
      U=C-(A*A-B*B)/FN
      IF(U.EQ.0)GO TO 84
      D=V/U
      D=ATAN(D)*CON
      IF(V)81,82,82
   81 IF(U)83,84,86
   82 IF(U)85,84,86
   83 V=D-180.
      GO TO 87
   84 IF(V.EQ.0)GO TO 90
      IF(V.LT.0)V=-90.
      IF(V.GT.0.)V=90
      GO TO 87
   85 V=180.+D
      GO TO 87
   86 V=D
   87 V=V/4.
      IF(ABS(V).GT..01)GO TO 91
   90 MX=MX-1
      GO TO 21
   91 V=V/CON
      A=SIN(V)
      B=COS(V)
      DO 20 I=1,NV
      D=F(I,J)*B+F(I,K)*A
      F(I,K)=-F(I,J)*A+F(I,K)*B
   20 F(I,J)=D
   21 CONTINUE
      RETURN
      END
      END$
```

III. NONPARAMETRIC STATISTICS

RANK (Column Ranking)

Purpose:

This program ranks data in a data file and creates a new file to be stored on the disc.

Layout of Design:

Ranking is done across columns independently of rows. In the case of a tied observation average ranks are assigned.

User Considerations and Procedures:

1. RANK expects a data file to be created in a row x column (R x C) matrix form. A printout of raw data would show C (column) elements per line. The created file has the same data format and record length as the original.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. Program has four options for data printout. Enter:

   1 for printout of raw data only

   2 for raw and ranked data printout

   3 for ranked data printout

   4 for no printout

4. Parameters required:

   a. number of columns (maximum 100)

   b. number of rows (maximum 32767)

   c. raw data file name

   d. format and record length of data file

   e. new file name (not same as raw data file)

5. Printout as optioned for only.

Comments:

Ranked data are used for program CHIRA.

PRECEDING PAGE BLANK-NOT FILMED

```
 RU,RANK
 ENTER NUMBER OF COLUMNS
8
 ENTER NUMBER OF ROWS
32
 ENTER DATA FILE NAME
#FATAA
 ENTER DATA FORMAT

(8(2X,F6.2))
 ENTER THE RECORD LENGTH AS IN DA3Ø
64
 ENTER OUTPUT FILE NAME
GEORGE
ENTER 1 FOR PRINTOUT OF ONLY RAW DATA, 2 FOR RAW DATA AND RANKED DATA,
  3 FOR ONLY RANKED DATA, AND 4 FOR NO PRINTOUT AT ALL
2
ENTER 1 FOR CRT DISPLAY, 6 FOR LPTR
6
:
```

RAW DATA

24.00	81.00	992.00	1024.0	978.00	1101.0	936.00	1120.0
25.00	22.00	181.00	310.00	293.00	346.00	188.00	166.00
27.00	57.00	124.00	172.00	166.00	491.00	154.00	83.00
29.00	36.00	553.00	719.00	605.00	833.00	585.00	346.00
30.00	54.00	1046.0	2221.0	1841.0	2656.0	1062.0	1030.0
31.00	25.00	322.00	522.00	402.00	676.00	261.00	379.00
32.00	78.00	838.00	364.00	222.00	433.00	1014.0	584.00
35.00	80.00	575.00	405.00	456.00	320.00	789.00	320.00
36.00	30.00	835.00	811.00	716.00	824.00	735.00	975.00
37.00	80.00	1001.0	166.00	179.00	154.00	907.00	1065.0
37.00	57.00	1418.0	1706.0	1656.0	1759.0	1024.0	219.00
45.00	74.00	531.00	503.00	581.00	593.00	481.00	593.00
77.00	66.00	218.00	637.00	681.00	591.00	300.00	201.00
80.00	47.00	133.00	109.00	112.00	106.00	166.00	108.00
80.00	80.00	74.00	100.00	115.00	90.00	79.00	68.00
80.00	74.00	550.00	322.00	422.00	204.00	600.00	400.00
18.00	61.00	72.00	429.00	456.00	411.00	405.00	856.00
19.00	18.00	67.00	760.00	356.00	509.00	966.00	3216.0
20.00	80.00	173.00	434.00	311.00	511.00	103.00	139.00
20.00	15.00	209.00	422.00	573.00	250.00	230.00	110.00
22.00	29.00	18.00	1024.0	1114.0	853.00	687.00	671.00
22.00	56.00	98.00	267.00	229.00	341.00	206.00	106.00
22.00	7.00	21.00	752.00	795.00	491.00	1252.0	1308.0
24.00	14.00	292.00	1312.0	1324.0	1296.0	1342.0	1851.0
80.00	51.00	116.00	777.00	1034.0	548.00	880.00	952.00
74.00	51.00	13.00	392.00	390.00	394.00	243.00	265.00
64.00	46.00	19.00	318.00	292.00	348.00	156.00	134.00
60.00	37.00	42.00	703.00	787.00	578.00	142.00	257.00
59.00	18.00	345.00	899.00	778.00	1141.0	424.00	411.00
54.00	14.00	49.00	968.00	747.00	1521.0	925.00	857.00
54.00	71.00	16.00	503.00	[illegible]21.00	964.00	275.00	226.00
51.00	53.00	15.00	198.00	201.00	193.00	591.00	236.00

RANKED DATA

1.00	2.00	5.00	6.00	4.00	7.00	3.00	8.00
2.00	1.00	4.00	7.00	6.00	8.00	5.00	3.00
1.00	2.00	4.00	7.00	6.00	8.00	5.00	3.00
1.00	2.00	4.00	7.00	6.00	8.00	5.00	3.00
1.00	2.00	4.00	7.00	6.00	8.00	5.00	3.00
2.00	1.00	4.00	7.00	6.00	8.00	3.00	5.00
1.00	2.00	7.00	4.00	3.00	5.00	8.00	6.00
1.00	2.00	7.00	5.00	6.00	3.50	8.00	3.50
2.00	1.00	7.00	5.00	3.00	6.00	4.00	8.00
1.00	2.00	7.00	4.00	5.00	3.00	6.00	8.00
1.00	2.00	5.00	7.00	6.00	8.00	4.00	3.00
1.00	2.00	5.00	4.00	6.00	7.50	3.00	7.50
2.00	1.00	4.00	7.00	8.00	6.00	5.00	3.00
2.00	1.00	7 00	5.00	6.00	3.00	8.00	4.00
4.50	4.50	2.00	7.00	8.00	6.00	3.00	1.00
2.00	1.00	7.00	4.00	6.00	3.00	8.00	5.00

1.00	2.00	3.00	6.00	7.00	5.00	4.00	8.00
2.00	1.00	3.00	5.00	6.00	4.00	7.00	8.00
1.00	2.00	5.00	7.00	6.00	8.00	3.00	4.00
2.00	1.00	4.00	7.00	8.00	6.00	5.00	3.00
2.00	3.00	1.00	7.00	8.00	6.00	5.00	4.00
1.00	2.00	3.00	7.00	6.00	8.00	5.00	4.00
3.00	1.00	2.00	5.00	6.00	4.00	7.00	8.00
2.00	1.00	3.00	5.00	6.00	4.00	7.00	8.00
2.00	1.00	3.00	5.00	8.00	4.00	6.00	7.00
3.00	2.00	1.00	7.00	6.00	8.00	4.00	5.00
3.00	2.00	1.00	7.00	6.00	8.00	5.00	4.00
3.00	1.00	2.00	7.00	8.00	6.00	4.00	5.00
2.00	1.00	3.00	7.00	6.00	8.00	5.00	4.00
3.00	1.00	2.00	7.00	4.00	8.00	6.00	5.00
2.00	3.00	1.00	7.00	6.00	8.00	5.00	4.00
2.00	3.00	1.00	5.00	6.00	4.00	8.00	7.00

```
*RANK  T=00003 IS ON CR00002 USING 00013 BLKS R=0000

      FTN4
            PROGRAM RANK
            COMMON A(100),A1(100),NAME(3),IFMT(20)
            COMMON IB(272),IC(272),IBUF(256),ISIZE(2)
            DO 109 I=1,100
            A(I)=0.
            A1(I)=0.
      109   CONTINUE
            WRITE(1,17)
      17    FORMAT(" ENTER NUMBER OF COLUMNS ")
            READ(1,*) NC
            WRITE(1,16)
      16    FORMAT(" ENTER NUMBER OF ROWS")
            READ(1,*) NR
            WRITE(1,15)
      15    FORMAT(" ENTER DATA FILENAME")
            READ(',1) NAME
      1     FORMAT(3A2)
            WRITE(1,14)
      14    FORMAT(" ENTER DATA FORMAT")
            READ(1,11)IFMT
      11    FORMAT(20A2)
            WRITE(1,88)
      88    FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
            READ(1,*) LENGTH
            LEN=LENGTH/2
            IF((LEN*2).NE.LENGTH) LEN=LEN+1
            LENGTH=LEN
            IDCBS=LENGTH
            IF(LENGTH.LT.144) IDCBS=144
            CALL OPEN(IB,IER,NAMF,3,0,-2,IDCBS)
            IF(IER.GE. 0) GO TO 543
            WRITE(1,566) NAME,IER
      566   FORMAT(5X,3A2," FAILED TO OPEN ,  IER = ",I5)
            STOP 566
      543   WRITE(1,12)
      12    FORMAT(" ENTER OUTPUT FILENAME")
            READ(1,1)NAME
            ISIZE(2)=LENGTH
            SIZE=LENGTH
            XSU=NR
            SIZE=XSU*SIZE/128. + 1.
            ISIZE(1)=SIZE
            CALL CREAT(IC,IER,NAME,ISIZE,2,0,-2,IDCBS)
            IF(IER.GE.0) GO TO 350
            WRITE(1,566) NAME,IER
            STOP 567
      350   DO 100 M5=1,NR
            L1=1
            N=0
            CALL READF(IB,IER,IBUF)
            CALL CODE
```

```
      READ(IBUF,IFMT)(A(K),K=1,NC)
 2    ALOW=9999.99
      N=N+L1
      DO 3 K=1,NC
      IF(A(K).EQ.9999.99)GO TO 3
      IF(A(K).LT.ALOW)ALOW=A(K)
 3    CONTINUE
      IF(ALOW.EQ.9999.99)GO TO 10
      L1=0
      C=0
      DO 5 K=1,NC
      IF(A(K).NE.ALOW)GO TO 5
      L1=L1+1
      C=C+N+L1-1
 5    CONTINUE
      C=C/L1
      DO 4 K=1,NC
      IF(A(K).NE.ALOW)GO TO 4
      A1(K)=C
      A(K)=9999.99
 4    CONTINUE
      GO TO 2
 10   CALL CODE
      WRITE(IBUF,IFMT)(A1(K),K=1,NC)
      CALL WRITF(IC,IER,IBUF)
 100  CONTINUE
      WRITE(1,159)
 159  FORMAT("ENTER 1 FOR PRINTOUT OF ONLY RAW DATA,2 FOR RAW DATA ",
     $/,"  AND RANKED DATA,3 FOR ONLY RANKED DATA , AND 4 FOR NO ",/
     $,"PRINTOUT AT ALL")
      READ(1,*) IPTO
      IF((IPTO.LT.1).OR.(IPTO.GE.4)) GO TO 32
      WRITE(1,160)
 160  FORMAT("ENTER 1 FOR CRT DISPLAY, 6 FOR LPTR")
      READ(1,*) IUNIT
      CALL RWNDF(IB)
      CALL RWNDF(IC)
      IF(IPTO.EQ.3) GO TO 788
      WRITE(IUNIT,209)
 209  FORMAT(//,5X,"RAW DATA",//)
      DO 137 I=1,NR
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (A(K),K=1,NC)
 137  WRITE(IUNIT,IFMT) (A(K),K=1,NC)
      IF(IPTO.EQ.1)  GO TO 32
 788  WRITE(IUNIT,237)
 237  FORMAT(///,5X,"RANKED DATA "/)
      DO 273 I=1,NR
      CALL READF(IC,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (A1(K),K=1,NC)
 273  WRITE(IUNIT,391) (A1(K),K=1,NC)
 391  FORMAT(10(1X,F6.2))
 32   CALL CLOSE (IB,IER)
      CALL CLOSE (IC,IER)
      END
      END$
```

ORANK (Matrix Ranking)

Purpose:

This program ranks data in a data file and creates a new file to be stored on disc.

Layout of Design:

Unlike the program RANK, ranking is done for entire data set. In case of tied observations, ranks are assigned randomly.

User Considerations and Procedures:

1. Program expects data file to be created in a row x column (R x C) matrix format. A printout of raw data would have C (column) elements per line. The created data file would be in R x C matrix form with different data format and record length.

2. Parameters required:

   a. raw data file name

   b. ranked data file name

   c. raw data format and record length

   d. ranked data format and record length

   e. number of records (rows) (see comments)

   f. number of columns (see comments)

3. There is no printout of the ranked data.

Comments:

The maximum size of parameters, row (R) and column (C), is as follows:

1. $C \leqslant 30$

2. $R * C \leqslant 2500$

```
 RU,ORANK
PROGRAM TO RANK ENTIRE DATA SET BY ROWS AND COLUMNS
ENTER NAME OF INPUT DATA FILE
#FATAA
ENTER NAME OF OUTPUT DATA FILE
#UWF
ENTER INPUT DATA FILE FORMAT
(8(2X,F6.2))
ENTER OUTPUT DATA FILE FORMAT
(8(2X,F6.2))
 ENTER THE RECORD LENGTH AS IN DA30
64
 ENTER THE OUTPUT RECORD LENGTH AS IN DA30
64
 ENTER IN NUMBER OF RECORDS
32
 ENTER IN NUMBER OF VARIABLES
8
  ORANK  :  STOP    0000
:LL,6
:LI,#FATAA,A
:LI,#UWF,A
:
```

```
*ORANK T=00003 IS ON CR00002 USING 00012 BLKS R=0000

FTN4,L
      PROGRAM ORANK
      COMMON Y(2500),IB(272),IC(272),IBUF(256),ICUF(256),NAME(3),
     &INAME(3),IFMT(20),IFMT2(20),X(30),JJ(30),IREC,IVAR,ISIZE(2)
      COMMON Z(30)
      WRITE(1,1)
1     FORMAT("PROGRAM TO RANK ENTIRE DATA SET BY  ROWS AND COLUMNS")
      WRITE(1,2)
2     FORMAT("ENTER NAME OF INPUT DATA FILE")
      READ(1,3) NAME
3     FORMAT(3A2)
      WRITE(1,4)
4     FORMAT("ENTER NAME OF OUTPUT DATA FILE")
      READ(1,3) INAME
      WRITE(1,5)
5     FORMAT("ENTER INPUT DATA FILE FORMAT")
      READ(1,6) IFMT
6     FORMAT(20A2)
      WRITE(1,7)
7     FORMAT("ENTER OUTPUT DATA FILE FORMAT")
      READ(1,6) IFMT2
      WRITE(1,88)
88    FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
      READ(1,*) LENGTH
      LEN=LENGTH/2
      IF((LEN*2).NE.LENGTH) LEN=LEN+1
      LENGTH=LEN
      IDCBS=LENGTH
      IF(LENGTH.LT.144) IDCBS=144
      CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
      IF(IER.GT.0) GO TO 8
      WRITE(1,9) NAME,IER
9     FORMAT(3A2," FAILED TO OPEN , IER = ",I5)
      STOP 1
8     CONTINUE
      WRITE(1,89)
89    FORMAT(" ENTER THE OUTPUT RECORD LENGTH AS IN DA30")
      READ(1,*) LENGTH
      LEN=LENGTH/2
      IF((LEN*2).NE.LENGTH) LEN=LEN+1
      LENGTH=LEN
      IDCBS=LENGTH
      IF(LENGTH.LT.144) IDCBS=144
      WRITE(1,10)
10    FORMAT("ENTER IN NUMBER OF RECORDS")
      READ(1,*) IREC
      WRITE(1,11)
11    FORMAT("ENTER IN NUMBER OF VARIABLES")
      READ(1,*) IVAR
      ITOTAL=IREC*IVAR
```

```
      SIZE=LENGTH
      ISIZE(2)=LENGTH
      XG=IREC
      SIZE=XG*SIZE/128. + 1
      ISIZE(1)=SIZE
      CALL CREAT(IC,IER,INAME,ISIZE,2,0,-2,IDCBS)
      IF(IER.LT.0) WRITE(1,9) INAME,IER
      IF(IER.LT.0) CALL CLOSE(IB)
      IF(IER.LT.0) STOP
      DO 12 J=1,IREC
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(X(I),I=1,IVAR)
      DO 13 I=1,IVAR
      L=(J-1)*IVAR+I
13    Y(L)=X(I)
12    CONTINUE
      CALL SORT(ITOTAL)
      CALL RWNDF(IB)
      DO 50 K=1,IREC
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (X(I3),I3=1,IVAR)
      DO 51 J=1,IVAR
      DO 52 I=1,ITOTAL
      IF(X(J).NE.Y(I)) GO TO 52
      Y(I)=-999.363
      Z(J)=I
      GO TO 51
52    CONTINUE
51    CONTINUE
      CALL CODE
      WRITE(ICUF,IFMT2) (Z(I4),I4=1,IVAR)
      CALL WRITF(IC,IER,ICUF)
50    CONTINUE
26    CALL CLOSE(IB)
      CALL CLOSE(IC)
      STOP
      END
      SUBROUTINE SORT(N)
      COMMON Y(2500)
      N1=N-1
      DO 1 I=1,N1
      J=1+I
      DO 2 K=J,N
      IF(Y(I).LE.Y(K)) GO TO 2
      TEMP=Y(I)
      Y(I)=Y(K)
      Y(K)=TEMP
2     CONTINUE
1     CONTINUE
      END
      END$
```

STACH (Nonparametric Descriptive Statistics)

Purpose:

This program is a descriptive package for nonparametric data which includes the following statistics: mean, median, standard deviation, middle 80 percentile range, semi-interquartile range, alpha 3, and alpha 4. This program also performs a chi-squared goodness of fit test for testing normality based on a frequency histogram of the raw data.

Mathematical Model:

The program creates a histogram, with a specified number of classes, from the raw data. Then, it standardizes each variable by the mean and variance of the histogram. The chi-squared value is determined by comparison of the histogram class frequency against the expected standard normal class frequency. This is done by:

$$Chi^2 = \sum_{i=1}^{N} \left[\frac{(f_i - E(f_i))^2}{E(f_i)} \right]$$

where:

f_i = actual frequency

$E(f_i)$ = expected frequency

N = number of classes

User Considerations and Procedures:

1. Program expects data created in matrix form. Each record contains X_{ij}; j = 1, M; where M = number of variables in data set; and i = the observation (or subject number). A printout of raw data would show m data points per line.

2. The data analysis can be either displayed on the CRT or hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. A printout of the histogram can be obtained. Enter 1 if a histogram printout is desired, 0 for no printout.

5. Program asked if test for normality is wanted. Respond 1 for yes. If only the histogram and/or different nonparametric statistics are desired, respond 0.

6. An option for IAP (rerun program) exists, respond 1 if you wish to rerun program, 0 for no.

7. A printout if the expected normal frequencies can be obtained. Enter 1 if desired, 0 if not.

8. Parameters required:

   a. number of variables in data file (maximum 100)

   b. number of subjects (maximum 32767)

   c. number of classes in histogram (maximum 25)

   d. number of variables to be analyzed (maximum 100)

   e. enter variable numbers which are to be analyzed

   f. name of data file

   g. format and record length of data file (see DA30)

9. Printout gives:

   a. number of observations, mean, median, mode, standard deviation, middle 80 percent range, semi-interquartile range, alpha 3, alpha 4, for each requested variable

   b. frequency histogram (optional)

   c. expected normal frequency (optional)

   d. chi-squared value and degrees of freedom (optional)

Comments:

The results of the chi-squared test gives the calculated chi-squared value with its degrees of freedom. To determine the probability level go to a chi-squared table. This test is very conservative; data have to be very unnormal to reject null hypothesis.

Test Data:

The data used to test this program is the same as SRM30 (See SRM30). This program was hand-tested using a Texas Instrument calculator software program. The progrqm uses double precision for most variables.

```
 RU,STACH
ENTER NUMBER OF VARIABLES
8
ENTER THE NUMBER OF VARIABLES TO BE ANALYZED
1
ENTER NUMBER OF SUBJECTS
64
ENTER # OF CLASSES IN THE POLYGON; MAX=25
8
POLYGON WANTED?  1=YES, Ø=NO
1
TEST FOR NORMALITY WANTED?  1=YES, Ø=NO
1
   IAP    1=YES,  Ø = NO
Ø
ENTER DATA FILE NAME
#STACH
ENTER DATA FORMAT
(8(2X,F6.2))
ENTER THE RECORD LENGTH AS IN DA3Ø
64
ENTER 1 FOR CRT OUTPUT, 6 FOR LP
6
ENTER NUMBER OF VARIABLES TO BE INCLUDED
1
ENTER 1 FOR RAW DATA PRINTOUT
Ø
ENTER 1 FOR PRINTOUT OF EXPECTED VALUES
1
:
```

```
STATISTICS FOR VARIABLE                1
NUMBER  =                             64
MEAN  =                           42.750
MEDIAN  =                         35.500
MODE  =                           25.500
STANDARD DEVIATION  =             21.034
MIDDLE 80 PCT RANGE  =            57.173
SEMI INTERQUARTILE RANGE  =       18.133
ALPHA 3  =                          .561
ALPHA 4  =                         1.813


FREQUENCY POLYGON VARIABLE             1
17.500   25.500   XXXXXXXXXXXXXXXXXXXX
25.500   33.500   XXXXXXXXXX
33.500   41.500   XXXXXXXXX
41.500   49.500   XX
49.500   57.500   XXXXXX
57.500   65.500   XXXXXX
65.500   73.500
73.500   81.500   XXXXXXXXXXXX

EXPECTED NORMAL VALUES
     13.1892185
      7.9343309
      9.3600349
      9.5714035
      8.4840889
      6.5187569
      4.3416157
      4.6005507

VARIABLE  1  CHI SQUARED FOR NORMALITY  =  12.056,DF = 6
 CK   3
 CK   4
 CK   5
```

```
*STACH T=00004 IS ON CR00002 USING 00028 BLKS R=0243

      FTN4
            PROGRAM STACH
            DOUBLE PRECISION Z1,T1,V(25)
            COMMON SC(100),IBUF(256),IB(272),NJ(2),NAME(3),IFMT(20),
           CNUL(100)
           $,LINE(100),FR(25),VLL(25),V,THE(25)
            INTEGER BLANK,EX
            DATA BLANK/2H  /,EX/2HX /
      101   CONTINUE
            WRITE(1,395)
      395   FORMAT("ENTER NUMBER OF VARIABLES")
            READ(1,*) NV
            WRITE(1,298)
      298   FORMAT("ENTER THE NUMBER OF VARIABLES TO BE ANALYIZED")
            READ(1,*) NW
            WRITE(1,299)
      299   FORMAT("ENTER NUMBER OF SUBJECTS")
            READ(1,*) NP
            WRITE(1,330)
      330   FORMAT("ENTER # OF CLASSES IN THE POLYGON ; MAX=25")
            READ(1,*) NC
            WRITE(1,332)
      332   FORMAT("POLYGON WANTED ? 1 = YES  0=NO")
            READ(1,*) NJ(1)
            WRITE(1,331)
      331   FORMAT("TEST FOR NORMALITY WANTED ? 1=YES  0=NO")
            READ(1,*) NJ(2)
            WRITE(1,334)
      334   FORMAT("   IAP   1=YES   0=NO")
            READ(1,*) IAP
            WRITE(1,333)
      333   FORMAT("ENTER DATA FILE NAME")
            READ(1,1002) NAME
      1002  FORMAT(3A2)
            WRITE(1,1003)
      1003  FORMAT("ENTER DATA FORMAT")
            READ(1,1004) IFMT
      1004  FORMAT(20A2)
            WRITE(1,88)
      88    FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
            READ(1,*) LENGTH
            LEN=LENGTH/2
            IF((LEN*2).NE.LENGTH) LEN=LEN+1
            LENGTH=LEN
            IDCBS=LENGTH
            IF(LENGTH.LT.144) IDCBS=144
            CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
            IF(IER.GE.0) GO TO 73
            WRITE(1,39) NAME,IER
      39    FORMAT(3A2,"  FAILED TO OPEN , IER = ",I3)
```

```
      STOP
73    WRITE(1,98)
98    FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LP")
      READ(1,*) IUNIT
      WRITE(1,934)
934   FORMAT("ENTER NUMBER OF VARIALBES TO BE INCLUDED")
      READ(1,*) (NWL(I),I=1,NW)
      WRITE(1,437)
437   FORMAT("ENTER 1 FOR RAW DATA PRINTOUT")
      READ(1,*) IPTO
      WRITE(1,3487)
3487  FORMAT("ENTER 1 FOR PRINTOUT OF EXPECTED VALUES")
      READ(1,*) ITP
      DO 231 I31=1,NW
      SUMX=0.
      SUMX2=0.
      DO 4 I=1,NP
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (SC(J),J=1,NV)
      IF (IPTO.EQ.1) WRITE(IUNIT,IFMT) (SC(J),J=1,NV)
      X=SC(NWL(I31))
      SUMX=SUMX+X
      SUMX2=SUMX2+X*X
      IF(I.NE.1)GO TO 400
      XL=X
      XH=X
400   IF(X.LT.XL) XL=X
      IF(X.GT.XH) XH=X
4     CONTINUE
      SNC=NC
      IPTO=0
      SNP=NP
      RINC=XH-XL+1
      CI=RINC/SNC
      NCI=CI+.99999
      CI=NCI
      DO 7 K=1,NC
7     FR(K)=0
      DO 8 K=1,NC
      FK=K
8     YLL(K)=XL-.5+(FK-1)*CI
      CALL RWNDF(IB)
      DO 9 I=1,NP
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(SC(J),J=1,NV)
      XC=SC(NWL(I31))
      KK=(XC-YLL(1))/CI+1
10    FR(KK)=FR(KK)+1
9     CONTINUE
```

```
      COD1=.1*SNP
      COQ1=.25*SNP
      COD5=.5*SNP
      COQ3=.75*SNP
      COD9=.9*SNP
      SX=0
      SSX=0
      SCX=0
      SQX=0
      DO 12 J=1,NC
      SNC=J
      AA=VLL(1)+CI*(SNC-.5)
      SX=SX+FR(J)*AA
      SSX=SSX+FR(J)*(AA**2)
      SCX=SCX+FR(J)*(AA**3)
12    SQX=SQX+FR(J)*(AA**4)
      CTM=SX/SNP
      SIG=SQRT(SNP*SSX-SX**2)/SNP
      ALPH=SCX-3*CTM*SSX+2*SNP*(CTM**3)
      ALPH=ALPH/(SNP*(SIG**3))
      BET=SQX-4*SCX*CTM+6*SSX*(CTM**2)-3*SNP*(CTM**4)
      BET=BET/(SNP*(SIG**4))
      AA=0
      DO 14 J=1,NC
      BB=AA+FR(J)
      IF(BB.GE.COD1)GO TO 15
      AA=BB
      GO TO 14
15    DE1=VLL(J)+CI*(COD1-AA)/FR(J)
      GO TO 16
14    CONTINUE
16    AA=0
      WRITE(IUNIT,663)
663   FORMAT("  CK  3   ")
      DO 17 J=1,NC
      BB=AA+FR(J)
      IF(BB.GE.COQ1)GO TO 18
      AA=BB
      GO TO 17
18    QT1=VLL(J)+CI*(COQ1-AA)/FR(J)
      GO TO 19
17    CONTINUE
19    AA=0
      DO 20 J=1,NC
      BB=AA+FR(J)
      IF(BB.GE.COD5)GO TO 21
      AA=BB
      GO TO 20
21    DE5=VLL(J)+CI*(COD5-AA)/FR(J)
      GO TO 22
20    CONTINUE
22    AA=0
      DO 23 J=1,NC
      BB=AA+FR(J)
      IF(BB.GE.COQ3) GO TO 24
```

```
      AA=BB
      GO TO 23
24    QT3=VLL(J)+CI*(COQ3-AA)/FR(J)
      GO TO 25
23    CONTINUE
25    AA=0
      WRITE(IUNIT,664)
664   FORMAT("    CK   4     ")
      DO 26 J=1,NC
      BB=AA+FR(J)
      IF(BB.GE.COD9)GO TO 27
      AA=BB
      GO TO 26
27    DE9=VLL(J)+CI*(COD9-AA)/FR(J)
      GO TO 28
26    CONTINUE
28    RM80=DE9-DE1
      SIQ=(QT3-QT1)/2
      AA=FR(1)
      NX=1
      DO 29 J=1,NC
      IF(FR(J).GT.AA)NX=J
      IF(FR(J).GT.AA)AA=FR(J)
29    CONTINUE
      WRITE(IUNIT,667)
667   FORMAT("   CK   5   ")
      NNX=NX+1
      NMX=NX-1
      RAT=(FR(NMX))/(FR(NNX)+FR(NMX))
      VMOD=VLL(NX)+RAT*CI
      I9=IUNIT
      WRITE(I9,30)I31,NP,CTM,DE5,VMOD,SIG,RM80,SIQ,ALPH,BET
30    FORMAT(1H1,"STATISTICS FOR VARIABLE",I3/1X,"NUMBER  =",I4/
     X1X,"MEAN  =",F7.3/1X,"MEDIAN=",F7.3/1X,"MODE  =",F7.3/1X,
     X"STANDARD DEVIATION  =",F7.3/1X,"MIDDLE 80 PCT RANGE  ",
     XF7.3/1X,
     X"SEMI INTERQUARTILE RANGE  =",F7.3/1X,"ALPHA 3  =",F7.3/1X,
     X"ALPHA 4  =",F7.3)
      IF(NJ(1).EQ.0)GO TO 200
      WRITE(IUNIT,31)I31
31    FORMAT(1H1,"FREQUENCY POLYGON VARIABLE  ",I3)
      DO 32 J=1,NC
      DO 33 K=1,100
33    LINE(K)=BLANK
      NBAR=FR(J)
      IF(NBAR.EQ.0)GO TO 100
      DO 34 K=1,NBAR
34    LINE(K)=EX
100   HL=VLL(J)+CI
      WRITE(IUNIT,35)VLL(J),HL,(LINE(K),K=1,100)
35    FORMAT(1H0,F7.3,1H ,F7.3,2X,100A1)
32    CONTINUE
200   IF(NJ(2).EQ.0)GO TO 11
```

```
      CHI=0
C     SIG=SQRT((SUMX2-SUMX*SUMX/SNP)/(SNP-1.))
C     CTM=SUMX/SNP
      DO 93 IJ=1,NC
      Z1=(VLL(IJ)-CTM)/SIG
      CALL YNORM(Z1,T1)
93    V(IJ)=T1
      NCC=NC-1
      THE(1)=SNP*V(2)
      DO 733 IV=2,NCC
      J3=IV+1
733   THE(IV)=SNP*DABS(V(J3)-V(IV))
734   FORMAT(5X,F14.7)
      THE(NC)=SNP*DABS(1-V(NC))
      IF(ITP.EQ.1) WRITE(IUNIT,9812)
9812  FORMAT(" EXPECTED NORMAL VALUES ",5X,F14.7)
      IF(ITP.EQ.1) WRITE(IUNIT,734) (THE(IK),IK=1,NC)
      DO 248 J=1,NC
      IF(J.EQ.NC)GO TO 40
      IF(THE(J).GE.5)GO TO 40
      K=J+1
      NCC=NCC-1
      THE(K)=THE(J)+THE(K)
      FR(K)=FR(K)+FR(J)
      GO TO 248
40    CHI=CHI+((FR(J)-THE(J))**2)/THE(J)
248   CONTINUE
      WRITE(IUNIT,41)I31,CHI,NCC
41    FORMAT(1H0/1X,"VARIABLE",I3," CHI SQUARED FOR NORMALITY=",F7.3,
     X",DF=",I3)
11    CONTINUE
231   CALL RWNDF(IB)
      CALL CLOSE(IB)
      IF(IAP.EQ.1) GO TO 101
      END
      END$
```

CHIRA (Coefficient of Concordance)

Purpose:

This program finds Kendall's coefficient of concordance, W, tests for its significance, and provides reliability figures of the ranked data. Wilcoxin sign rank, Z, can also be obtained for all variable combinations.

Mathematical Model and Layout of Design:

In our layout, we have N objects (or individuals) ranked in K-sets. Each set is ranked independently of each other.

$$
\begin{array}{c|cccccccc|}
 & 1 & 2 & 3 & . & . & . & . & N \\
\hline
1 & r_{11} & r_{12} & r_{13} & . & . & . & . & r_{1n} \\
2 & r_{21} & r_{22} & r_{23} & . & . & . & . & r_{2n} \\
3 & r_{31} & r_{32} & r_{33} & . & . & . & . & r_{3n} \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . & . \\
k & r_{k1} & r_{k2} & r_{k3} & & & & & r_{kn} \\
\hline
\end{array}
$$

1. Mount a magnetic tape! (any scratch tape will do).

2. Program expects ranked data in k x N matrix form to have been created (see program RANK). A printout of data would show N observations per line.

3. The data analysis can be either displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

4. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#3).

5. Program asks if Wilkoxin sign rank, Z, is desired. Enter 1 for yes, 0 for no. NOTE: The program prints out the Wilcoxin Z for all pairs of variables and an approximate probability. The number of signed ranks = N (N - 1)/2.

6. Parameters required:

   a. number of columns = N = (maximum 70)

   b. number of rows = k = (maximum 30)

   c. enter 1 for correction of ties (Not to correct for ties is incorrect! If data have been created using RANK, ties have already been assigned average ranks.)

   d. name of ranked data file

   e. format and record length of data file (see DA30)

7. Printout gives:

   a. raw data (optional)

   b. Wilkoxin Z (optional)

   c. Kendall's W, chi-square with degrees of freedom, average row reliability, and total reliability

   d. S, sum of squared deviations from mean of nth object (see comments)

Comments:

The hypothesis being tested with Kendall's W is whether k-sets of rankings are independent. Kendall's W expresses the degree of agreement among the k-sets (judges, etc.) in ranking the N objects. When $N > 7$, W is related to the chi-squared distribution by

$$X^2 = k(N - 1)W \text{ with } df = N - 1.$$

The program gives the X^2 value in all cases. If $N \leq 7$ this value will be incorrect. For critical values in this case ($N \leq 7$) see S. Siegel, Nonparametric Statistics for the Behavioral Sciences, Table R, P. 286. This table gives critical values of S, which the program prints out. The table shows minimum critical values of S for the .05 and .01 level of significance.

If $N > 7$, compare the chi-square for R, printed by program, with the chi-square value from any table of critical values (i.e., Table C, P. 249, in S. Siegel).

The average row reliability equals (kW - 1)/(W (k - 1)). Total reliability equals (kW -1)/(W (k - 1)).

In Wilcoxin Z, the hypothesis we are testing is whether 2 variables (in each Z) differ.

Test Data:

This program was tested using data from S. Siegel, Nonparametric Statistics for the Behavioral Sciences, McGraw-Hill, 1956, P. 233-237.

```
 RU,CHIRA
ENTER DATA FILE NAME
#CHIRA
 DO YOU WISH TO COMPUTE WITH TIES  1=YES, Ø=NO
1
 NUMBER OF COLUMNS (MAX 7Ø) :
4
 NUMBER OF ROWS (MAX 3Ø):
1Ø
 ENTER DATA FORMAT
(4(1X,F3.Ø))
 ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT
6
ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER Ø
1
DO YOU WANT WILKOXIN SIGN RANK Z?, 1=YES, Ø=NO
1
 ENTER  THE RECORD LENGTH AS IN DA3Ø
16
CHIR  :  STOP    ØØØØ
CTAPE ABORTED
:
```

RAW DATA

1.0000	2.0000	3.0000	4.0000
1.0000	2.0000	3.0000	4.0000
1.0000	2.0000	3.0000	4.0000
2.0000	1.0000	3.0000	4.0000
2.0000	1.0000	3.0000	4.0000
1.0000	2.0000	3.0000	4.0000
1.0000	3.0000	2.0000	4.0000
1.0000	2.0000	3.0000	4.0000
2.0000	1.0000	4.0000	3.0000
1.0000	2.0000	4.0000	3.0000

DATA CALCULATED WITH CORRECTIONS FOR TIES
CHI SQUARE FOR R = 23.880, DEGREES OF FREEDOM = 3
KENDALL'S W = .796
AVERAGE ROW RELIABILITY = .773 TOTAL RELIABILITY = .972

8 = 398.00000

VAR 1	AND VAR 2	WILCOXIN SIGNED RANK Z =	-1.274	# OF PAIRS = 10	ALPHA LEVEL SIGNIFICANCE =	.50
VAR 1	AND VAR 3	WILCOXIN SIGNED RANK Z =	-2.803	# OF PAIRS = 10	ALPHA LEVEL SIGNIFICANCE =	.01
VAR 1	AND VAR 4	WILCOXIN SIGNED RANK Z =	-2.803	# OF PAIRS = 10	ALPHA LEVEL SIGNIFICANCE =	.01
VAR 2	AND VAR 3	WILCOXIN SIGNED RANK Z =	-2.446	# OF PAIRS = 10	ALPHA LEVEL SIGNIFICANCE =	.02
VAR 2	AND VAR 4	WILCOXIN SIGNED RANK Z =	-2.803	# OF PAIRS = 10	ALPHA LEVEL SIGNIFICANCE =	.01
VAR 3	AND VAR 4	WILC[illegible]IGNED RANK Z =	-1.784	# OF PAIRS = 10	ALPHA LEVEL SIGNIFICANCE =	.50

```
CHIRA  T=00004 IS ON CR00002 USING 00001 BLKS R=0005

0001     :SV,4
0002     :RP,CTAPE
0003     :RU,CHIR
0004     :OF,CTAPE
0005     :SV,0
```

```
*CHIR  T=00003 IS ON CR00002 USING 00021 BLKS R=0000

FTN4
          PROGRAM CHIR
          COMMON SC(30,70),RS(70),D(30),DR(30),RA(30,70)
          DIMENSION TAB(25,3),IFMT(20),ITAPE(3)
          DATA ITAPE/2HCT,2HAP,2HE /
          DATA TAB(6,1),TAB(6,2),TAB(6,3)/2.227,99.999,99.999/
          DATA TAB(7,1),TAB(7,2),TAB(7,3)/2.028,2.366,99.999/
          DATA TAB(8,1),TAB(8,2),TAB(8,3)/1.960,2.240,2.521/
          DATA TAB(9,1),TAB(9,2),TAB(9,3)/1.955,2.310,2.429/
          DATA TAB(10,1),TAB(10,2),TAB(10,3)/1.988,2.293,2.497/
          DATA TAB(11,1),TAB(11,2),TAB(11,3)/1.956,2.312,2.490/
          DATA TAB(12,1),TAB(12,2),TAB(12,3,/1.961,2.275,2.510/
          DATA TAB(13,1),TAB(13,2),TAB(13,3)/1.992,2.271,2.481/
          DATA TAB(14,1),TAB(14,2),TAB(14,3)/1.977,2.291,2.480/
          DATA TAB(15,1),TAB(15,2),TAB(15,3)/1.988,2.272,2.499/
          DATA TAB(16,1),TAB(16,2),TAB(16,3)/1.965,2.275,2.482/
          DATA TAB(17,1),TAB(17,2),TAB(17,3)/1.965,2.296,2.533/
          DATA TAB(18,1),TAB(18,2),TAB(18,3)/1.982,2.286,2.504/
          DATA TAB(19,1),TAB(19,2),TAB(19,3)/1.972,2.294,2.535/
          DATA TAB(20,1),TAB(20,2),TAB(20,3)/1.979,2.315,2.501/
          DATA TAB(21,1),TAB(21,2),TAB(21,3)/1.964,2.311,2.520/
          DATA TAB(22,1),TAB(22,2),TAB(22,3)/1.964,2.289,2.516/
          DATA TAB(23,1),TAB(23,2),TAB(23,3)/1.977,2.312,2.524/
          DATA TAB(24,1),TAB(24,2),TAB(24,3)/1.971,2.314,2.543/
          DATA TAB(25,1),TAB(25,2),TAB(25,3)/1.978,2.301,2.543/
     50   REWIND 8
     173  S=0
          CALL EXEC(9,ITAPE)
          REWIND 8
          READ(8,239) IER,ICOM
          IF (IER.LT.0) GO TO 333
     239  FORMAT(2I5)
          READ(8,2031) ITIES,NK,NR,IUNIT
     2031 FORMAT(4I5)
          READ(8,2033) IFMT
     2033 FORMAT(20A2)
          DO 70 I=1,70
     70   RS(I)=0
          DO 71 I=1,30
          DR(I)=0.
     71   D(I)=0
          SUM=0
          T=0
          DO 2 I=1,NR
          READ(8,IFMT) (SC(I,J),J=1,NK)
     2    CONTINUE
          DO 4 I=1,NR
          DO 4 J=1,NK
          RA(I,J)=.5
          DO 4 K=1,NK
```

```
      IF(SC(I,J).EQ.SC(I,K))RA(I,J)=RA(I,J)+.5
      IF(SC(I,J).GT.SC(I,K))RA(I,J)=RA(I,J)+1
4     CONTINUE
      DO 60 I=1,NK
      DO 60 J=1,NR
60    RS(I)=RS(I)+RA(J,I)
      DO 22 I=1,NK
22    SUM=SUM+RS(I)
      SUM=SUM/NK
      DO 21 I=1,NK
21    S=S+(RS(I)-SUM)**2
      IF(ITIES.EQ.0)GO TO 61
      DO 32 J=1,NR
      N=1
      SUM=0
      DO 31 I=1,NK
      M=1
      K2=I+1
      DO 30 K=K2,NK
      IF(RA(J,I).NE.RA(J,K))GO TO 30
      M=M+1
      D(N)=RA(J,I)
30    CONTINUE
      IF(M.EQ.1)GO TO 31
      DO 29 K1=1,N
      IF(N.EQ.K1)GO TO 28
      IF(D(N).EQ.D(K1))GO TO 31
29    CONTINUE
28    SUM=SUM+(M**3-M)
      N=N+1
31    CONTINUE
      IF(N.EQ.1.AND.SUM.EQ.0)GO TO 32
      T=T+SUM/12
32    CONTINUE
61    ANK=NK
      ANR=NR
      WK=S/((((ANR**2)*(ANK**3-ANK))/12)-(ANR*T))
      CHIK=ANR*(ANK-1)*WK
      NDFK=NK-1
      ARB=(ANR*WK-1)/(ANR-1)
      SBR=ANR*ARB/(1+(ANR-1)*ARB)
      IF(ITIES.EQ.1) GO TO 52
      WRITE(IUNIT,53)
53    FORMAT(1H1," DATA CALCULATED WITHOUT CORRECTION FOR TIES")
      GO TO 51
52    WRITE(IUNIT,54)
54    FORMAT(1H1," DATA CALCULATED WITH CORRECTIONS FOR TIES")
51    WRITE(IUNIT,9)CHIK,NDFK
9     FORMAT(" CHI SQUARE FOR R= ",F8.3," ,DEGREES OF FREEDOM =",I3)
      WRITE(IUNIT,10)WK
10    FORMAT(" KENDALL'S W= ",F6.3)
      WRITE(IUNIT,11)ARB,SBR
11    FORMAT(" AVERAGE ROW RELIABILITY = ",F6.3," TOTAL REL",
     1"IABILITY = ",F6.3,//)
      WRITE(IUNIT,936) S
```

```
 936  FORMAT("      S = ",5X,F10.5,//)
      IF(ICOM.NE.1) STOP
      DO 200 I=1,30
 200  DR(I)=0
      NKR=NK-1
      DO 12 I=1,NKR
      II=I+1
      DO 12 J=II,NK
      NN=NR
      DO 13 K=1,NR
 13   D(K)=SC(K,I)-SC(K,J)
      NPLUS=0
      DO 14 K=1,NR
      IF(D(K).EQ.0)DR(K)=0
      IF(D(K).EQ.0)NN=NN-1
      IF(D(K).EQ.0)GO TO 14
      IF(D(K).GT.0)NPLUS=NPLUS+1
      DR(K)=.5
      DO 14 L=1,NR
      IF(D(L).EQ.0)GO TO 14
      IF(ABS(D(K)).EQ.ABS(D(L)))DR(K)=DR(K)+.5
      IF(ABS(D(K)).GT.ABS(D(L)))DR(K)=DR(K)+1
 14   CONTINUE
      NNH=(NN/2)
      T=0
      IF(NPLUS.GT.NNH)GO TO 16
      DO 17 K=1,NR
      IF(D(K).GT.0)T=T+DR(K)
 17   CONTINUE
      GO TO 19
 16   DO 18 K=1,NR
      IF(D(K).LT.0)T=T+DR(K)
 18   CONTINUE
 19   FNN=NN
      TOP=FNN*(FNN+1)/4
      BOT=SQRT(TOP*(2*FNN+1)/6)
      ZEE=(T-TOP)/BOT
      IF(NN.LT.6)GO TO 100
      IF(NN.GE.6.AND.NN.LE.25)GO TO 101
      PR=.5
      IF(ZEE.GE.1.96)PR=.05
      IF(ZEE.GE.2.327)PR=.02
      IF(ZEE.GE.2.575)PR=.01
      GO TO 102
 101  PR=.5
      IF(ABS(ZEE).GE.TAB(NN,1))PR=.05
      IF(ABS(ZEE).GE.TAB(NN,2))PR=.02
      IF(ABS(ZEE).GE.TAB(NN,3))PR=.01
      GO TO 102
 100  PR=.5
 102  WRITE(IUNIT,20)I,J,ZEE,NN,PR
 20   FORMAT(" VAR ",I3," AND VAR ",I3,"   WILCOXIN SIGNED RANK Z =",
     XF8.3,"   # OF PAIRS = ",I3,"  ALPHA LEVEL SIGNIFICANCE =",F8.3,
     X//)
 12   CONTINUE
 333  STOP
      END
      END$
```

```
"CTAPE T=00003 IS ON CR00002 USING 00009 BLKS R=0000

FTN4
          PROGRAM CTAPE
          COMMON SC(70),INAME(3),IFMT(20),IB(272),IBUF(256)
          WRITE(1,121)
121       FORMAT("ENTER DATA FILE NAME")
          READ(1,98) INAME
98        FORMAT(3A2)
          WRITE(1,194)
          REWIND 8
          READ(1,*) ITIES
194       FORMAT( " DO YOU WISH TO COMPUTE WITH TIES 1=YES, 0=NO ")
          WRITE(1,195)
          READ(1,*) NK
195       FORMAT(" NUMBER OF COLUMNS (MAX 70)  :     ")
          WRITE(1,196)
196       FORMAT(" NUMBER OF ROWS (MAX 30) :     ")
          READ(1,*) NR
          WRITE(1,198)
198       FORMAT(" ENTER DATA FORMAT")
          READ(1,199)IFMT
199       FORMAT(20A2)
          WRITE(1,987)
987       FORMAT(" ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT")
          READ(1,*) IUNIT
          WRITE(1,45)
45        FORMAT("ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0")
          READ(1,*) IPTO
          WRITE(1,393)
393       FORMAT("DO YOU WANT WILKOXIN SIGN RANK Z  ? , 1=YES, 0=NO")
          READ(1,*) ICOM
          WRITE(1,88)
88        FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
          READ(1,*) LENGTH
          LEN=LENGTH/2
          IF((LEN*2).NE.LENGTH) LEN=LEN+1
          LENGTH=LEN
          IDCBS=LENGTH
          IF(LENGTH.LT.144) IDCBS=144
          CALL OPEN(IB,IER,INAME,3,0,-2,IDCBS)
          IF(IER.GE.0) GO TO 123
          WRITE(1,145) INAME,IER
145       FORMAT(3A2,"  FAILED TO OPEN , IER = ",I5)
          WRITE(8,20) IER,ICOM
20        FORMAT(2I5)
          REWIND 8
          STOP 145
123       CONTINUE
          WRITE(8,20) IER,ICOM
          WRITE(8,204) ITIES,NK,NR,IUNIT
204       FORMAT(4I5)
```

```
      WRITE(8,205) IFMT
205   FORMAT(20A2)
      DO 10 I=1,NR
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (SC(J),J=1,NK)
      WRITE(8,IFMT) (SC(J),J=1,NK)
      IF(IPTO.EW.1) WRITE(IUNIT,209) (SC(J),J=1,NK)
209   FORMAT(8F10.4)
      IF(IPTO.EQ.1) WRITE(IUNIT,2090)
2090  FORMAT(5X)
10    CONTINUE
      REWIND 8
      CALL CLOSE(IB)
      END
      END$
```

CHISQ (Chi-square)

Purpose:

This program performs a chi-squared test for independence on a row by column (R x C) contingency table and calculates tne contingency coefficient.

Layout of Design:

	A_1	A_2	. . . . .	A_c	Total
B_1	ab_{11}	ab_{12}	. . . . .	ab_{1c}	$R_{1.}$
B_2	ab_{21}	ab_{22}	. . . . .	ab_{2c}	$R_{2.}$
.	.	.	. . . . .	.	.
.	.	.	. . . . .	.	.
.	.	.	. . . . .	.	.
.	.	.	. . . . .	.	.
B_r	ab_{r1}	ab_{r2}	. . . . .	ab_{rc}	$R_{r.}$
Total	$R_{.1}$	$R_{.2}$		$R_{.c}$	N

where:

$R_{.i}$ = total in ith column

$R_{j.}$ = total in jth row

N = overall total

Mathematical Model:

$$X^2 = \sum_{j=1}^{R} \sum_{i=1}^{C} \left[\frac{(O_{ij} - E_{ij})^2}{E_{ij}} \right]$$

where:

O_{ij} = observed value in i, jth position.

E_{ij} = expected value in i, jth position = $R_{.i} * R_{j.}/N$

The hypothesis to be tested is:

$$Ho: A_1 = A_2 = A_3 = A_c$$

User Considerations and Procedures:

1. Program expects data in a R x C matrix form. A printout of raw data would show C data points per line.

2. The data analysis can be either displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of columns (maximum 100)

   b. number of rows (maximum 100)

   c. data file name

   d. format and record length of data file (see DA30)

5. Printout gives:

   a. raw data if optioned

   b. calculated chi-squared value with d.f. = (R - 1)*(C - 1)

   c. the contingency coefficient, $C = (X^2/(X^2 + N))**.5$

Comments:

Program provides calculated chi-squared value which can be compared to a critical chi-square table to determine probability.

Test Data:

This program was tested using data from S. Siegel, Nonparametric Statistics for the Behavorial Sciences, McGraw-Hill, 1956, P. 198. Program uses double precision for accuracy.

```
 RU,CHISO
CHI-SQUARED TEST FOR INDEPENDENCE OF A RXC
    CONTINGENCY TABLE AND THE CONTINGENCY COEFFICIENT
    INPUT FILE NAME
#CHISO
 ENTER DATA FORMAT
(4(1X,F4.Ø))
NUMBER ACROSS
4
THE NUMBER DOWN:
3
 ENTER THE RECORD LENGTH AS IN DA3Ø
2Ø
ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER Ø
1
ENTER 1 FOR CRT OR 6 FOR LINEPRINTER OUTPUT
6

THE CONTINGENCY COEFFICIENT =    .38865
:
```

RA.; DATA

23.	40.	16.	2.
11.	75.	107.	14.
1.	31.	60.	10.

CHI-SQAURED = 69.3893283 DEGREES OF FREEDOM = 6

```
*CHISQ T=00003 IS ON CR00002 USING 00010 BLKS R=0000

FTN4
      PROGRAM CHISQ
      DOUBLE PRECISION E,X,Y.Z,CHIS,C,TOTAL
      DIMENSION X(100),Y(100),Z(100),NAME(3),IFMT(20)
      DIMENSION IB(272),IBUF(256)
      IUNIT=1
      WRITE(1,981)
981   FORMAT("CHI-SQUARED TEST FOR INDEPENDENCE FO A RXC ",/,
     $"    CONTINGENCY TABLE AND THE CONTINGENCY COEFFICIENT")
      WRITE(1,1111)
1111  FORMAT("  INPUT FILENAME")
      READ(1,1)NAME
1     FORMAT(3A2)
      WRITE(1,1112)
1112  FORMAT(" ENTER DATA FORMAT")
      READ(1,54)IFMT
54    FORMAT(20A2)
      WRITE(1,1113)
1113  FORMAT ("NUMBER ACROSS")
      READ(1,*) NC
      WRITE(1,114)
      READ(1,*) NR
114   FORMAT ("THE NUMBER DOWN :    ")
      TOTAL=0.
      CHIS=0.
      IDCBS=256
      CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
      IF(IER.GE.0) GO TO 123
      WRITE(1,124) NAME,IER
124   FORMAT(3A2,"  FAILED TO OPEN , IER = ",I5)
      STOP 123
123   CONTINUE
      WRITE(1,459)
459   FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0")
      READ(1,*) IPTO
      WRITE(1,56)
56    FORMAT("ENTER 1 FOR CRT OR 6 FOR LINPRINTER OUTPUT")
      READ(1,*) IUNIT
      IF(IPTO.NE.1) GO TO 987
      WRITE(IUNIT,3679)
3679  FORMAT(/,"RAW DATA",/)
987   WRITE(IUNIT,913)
913   FORMAT(///)
      DO 100 J=1,NR
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT) (X(I),I=1,NC)
      IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (X(I),I=1,NC)
      DO 100 I=1,NC
      Y(I)=Y(I)+X(I)
```

```
      Z(J)=Z(J)+X(I)
100   CONTINUE
      DO 101 J=1,NC
101   TOTAL=TOTAL+Y(J)
      CALL RWNDF(IB)
      DO 200 J=1,NR
      CALL READF(IB,IER,IBUF)
      CALL CODE
      READ(IBUF,IFMT)(X(I),I=1,NC)
      DO 200 I=1,NC
      E=Y(I)*Z(J)/TOTAL
200   CHIS=CHIS+(X(I)-E)*(X(I)-E)/E
      N=(NC-1)*(NR-1)
      C=DSQRT(CHIS/(CHIS+TOTAL))
      WRITE(IUNIT,9876) CHIS,N
9876  FORMAT(//,5X,"CHI-SQUARED =",F14.7,10X,,"DEGREES OF FREEDOM ="
     C,I5)
      WRITE(IUNIT,1115) C
1115  FORMAT(//" THE CONTINGENCY COEFFICIENT =     ",F10.5)
      CALL CLOSE(IB)
      END
      END$
```

APPENDIX A

GENERALIZED SUBROUTINES

APPENDIX A

GENERALIZED SUBROUTINES

FPROB and YNORM are subroutines used in many of the statistical programs. FPROB calculates the probability value for the F-statistic in the analyses of variance and covariance programs. There are five arguments for FPROB (F, DF1, DF2, Z, and P). The three parameters passed to the subroutine are the F-statistic value and the two degrees of freedoms associated with the F. The return parameters are the Z-value and the probability calculation, P. YNORM is used to normalize scores. There are two arguments for YNORM (DZ, YORMX). DZ is the initial score value which is passed to the subroutine; YORMX is the recalculated score that is returned to the original program. Program listings for these two subroutines are on the following pages.

*FPROB T=00003 IS ON CR00002 USING 00004 BLKS R=0000

```
FTN4,L
      SUBROUTINE FPROD(F,DF1,DF2,Z,P)
      DOUBLE PRECISION EDF1,EDF2,FA,T,A,B,TOP,BOT,CA,CB,CC,CD
      DOUBLE PRECISION F,DF1,DF2,Z,P
      P=1.0
      EDF1=DF1
      EDF2=DF2
      FA=F
      IF(F.LE.0.)GO TO 100
      IF(EDF1.LE.0.)GO TO 100
      IF(EDF2.LE.0.)GO TO 100
      IF(F.GE.1.0)GO TO 60
      FA=1.0/F
      T=EDF1
      EDF1=EDF2
      EDF2=T
60    A=2./(9.*EDF1)
      B=2./(9.*EDF2)
      TOP=(1.-B)*FA**(1./3.)-1.+A
      BOT=DSQRT(B*FA**(2./3.)+A)
      Z=DABS(TOP/BOT)
      IF(EDF2.GT.3.)GO TO 80
      Z=Z*(1.+.08*Z**4/EDF2**3)
80    CA=.196854
      CB=.115194
      CC=.000344
      CD=.019527
      T=Z*(CA+Z*(CB+Z*(CC+Z*CD)))
      T=(1.+T)**4
      P=.5/T
      IF(F.GE.1.0)GO TO 100
      P=1.-P
100   RETURN
      END
      END$
```

```
*YNORM T=00003 IS ON CR00002 USING 00006 BLKS R=0000

FTN4
      SUBROUTINE YNORM(DZ,YORMX)
      DOUBLE PRECISION DZ,DPI,YORMX,DX,DAL,DBL,DAH,DBH,DAN,DBI,DAI,
     $DFA,DFB,DAC,DBC
      DPI=.398942280401433
      DX=DABS(DZ)
      YORMX=0.0D0
      IF(DZ.LT.-18.D0) GO TO 99
      YORMX=1.D0
      IF(DZ.GT.9.D0) GO TO 99
      IF(DX.GT.3.D0) GO TO 10
      DAL=0.0D0
      DBL=1.0D0
      DAH=DX
      DBH=1.D0
      DAN=0.0D0
 5    DAN=DAN+1.0D0
      DAI=-(2.D0*DAN-1.D0)*DX*DX
      DBI=4.D0*DAN-1.D0
      DAL=DBI*DAH+DAI*DAL
      DBL=DBI*DBH+DAI*DBL
      DAI=DX*DX-DAI
      DBI=2.D0+DBI
      DAH=DBI*DAL+DAI*DAH
      DBH=DBI*DBL+DAI*DBH
      DFA=DAL/DBL
      DFB=DAH/DBH
      IF(DFB.EQ.0.D0) GO TO 20
      IF(DABS((DFB-DFA)/DFA).LE.1.D-10) GO TO 20
      GO TO 5
 10   DAL=0.0D0
      DBL=1.0D0
      DAH=1.0D0
      DBH=DX
      DBI=DX
      DAN=1.D0
      DFA=1.D0/DX
 15   DAN=DAN+1.0D0
      DAI=DAN-1.D0
      DAC=DBI*DAH+DAI*DAL
      DBC=DBI*DBH+DAI*DBL
      DFB=DAC/DBC
      DAL=DAH
      DBL=DBH
      DAH=DAC
      DBH=DBC
      IF(DFB.EQ.0.D0) GO TO 20
      IF(DABS((DFB-DFA)/DFB).LE.1.D-10) GO TO 20
      DFA=DFB
      GO TO 15
 20   YORMX=DPI*DFB*DEXP(-DX*DX/2.D0)
      IF(DX.LE.3.D0) YORMX=0.5D0-YORMX
      IF(DZ.GT.0.D0) YORMX=1.0D0-YORMX
 99   RETURN
      END
      END$
```

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Statistical Package User's Guide represents an aggregation of a variety of statistical analysis. The types of statistical programs available are: Analysis of Variance, Analysis of Covariance, Mul eriate Analysis of Variance, Regression Analysis, Factor Analysis, Descriptive Statistics, and Non-parametric Statistics. The User's Guide provides the following documentation for each program: General Description, Mathematical Model, Operational Procedures, Test Data Statistical Analysis, and Software coding.

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