A MANUAL OF GENERAL STATISTICAL PROGAMS FOR THE HONEYWELL 400 COMPUTER

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OHIO RIVER BASIN PROJECT

WORK PAPER No. I

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DISCLAIMER

Although these programs were tested by the author prior to inclusion, no warranty is expressed or implied as to the accuracy and functioning of these programs and related program material and no responsibility is assumed by the author in connection therewith.

FOREWORD

This manual is the result of the author's efforts to generate and assemble a useful group of general statistical programs for the Honeywell 400 Computer. Each of the programs in the text has been used in some area of the Public Health Service or the Federal Water Pollution Control Administration and each was written at the request of some member of one of these agencies.

These programs are written in a compiler language called AUTOMATH, the Honeywell 400 version of FORTRAN II, and can be adapted through simple modifications to operate on IBM equipment.

It is the author's hope that these programs may serve as an aid in stimulating both the use and future development of the more complex statistical computer programs needed for the solution of problems in the area of environmental health.

CONTENTS

AXRS04

GENERAL ROUTINE AXRS04
DETERMINATION OF REGRESSION COEFFICIENTS
DooLittle Method

PURPOSE: To find regression coefficients of a matrix of sums of squares and cross products.

RESTRICTIONS: 1) A maximum of 25 variables (independent plus dependent) can be treated at a time.

2) The maximum number of dependent variables which can be processed in any one run is ten.

3) Input to computer is on cards.

ACCURACY: Single precision floating point computations with eight significant digits.

OPTIONS: 1) The complete square matrix and its vectors or

2) The upper right triangularized portion of a matrix with its vectors may be submitted. (The program assumes that the first variables treated are independent and the last variables are dependent).

INPUT: Data may be punched on cards in any format which can be suitably described by an Automath Format statement. A considerable amount of running time can be saved by arranging the data so that they are treated by the READ statement in this manner (a) one observation of each variable in every read cycle (b) observations of all independent variables should PRECEDE observations of dependent variables in the same read cycle. Standard card format is seven fields of 10 digits each; the last 10 digits may be used for identification.

CARD DECK SETUP:

1. Program Source Deck - complete with modified FORMAT statement (statement #1001).

2. Name Card - Describes run - uses card columns 2-80.

3. Parameter Card - Gives total number of variables (dependent plus independent) in card columns 1 and 2, the number of dependent variables only in card columns 11 and 12, number of degrees of freedom in card columns 21-24 and matrix configuration in card column 31 (1 = square matrix, 0 = right triangular portion of matrix).

4. Mean for each variable (7F10.5).

5. Total sum of squares for each dependent variable (7F10.5).

6. Data cards with FINIS.

OUTPUT: The following printout is presented for each dependent variable in the problem: Degrees of freedom - Total sums of squares - Sums of squares for error - Mean squares for error - Regression sums of squares - Multiple correlation coefficient (R^2) - Each regression coefficient with standard error - Student's T - Constant regression term - Inverse matrix solution.

DESCRIPTION & PROGRAM LISTING

```
      COMPLEX
 TITLEAXRS04
C     DETERMINATION OF REGRESSION COEFFICIENTS
C     DOOLITTLE METHOD
      DIMENSION X(25),A1(325),B(325),REGSS(10),XO(25),AVG(25),AV(26),
     1DIAG(25),D(25,25),C(25,25)
      DIMENSION TSS(10)
C     READ SQUARE MATRIX INTO C      MSQR=1
C     READ TRIANG MATRIX INTO A1     MSQR=0
  111 READ1000,NCI,ND,IDF,MSQR
      IF END OF FILE 33,3
    3 NC=NCI
      READ1002,(AV(I),I=1,NC)
      READ1002,(TSS(I),I=1,ND)
      ERASF(REGSS)
      M=NC-ND-1
      MM=M
      NP=NC-ND
      NJ=NC-ND
      NQ=NC-ND
      N1=1
      NN=NC+1
      NZ=2
      L2=1
      NT=NC
      NX=0
      NOELM=NQ*(NQ+1)/2+ND*NQ
      IF(MSQR)201,202,201
  201 READ1001,((C(I,J),J=1,NC),I=1,NQ)
      KK=0
      DO 205I=1,NQ
      DO 205 J=I,NC
  204 KK=KK+1
  205 A1(KK)=C(I,J)
      GO TO 206
  202 READ1001,(A1(I),I=1,NOELM)
  206 DO 12J=N1,NQ
  300 DO 5I=N1,NC
    5 B(I)=A1(I)/A1(N1)
      DIAGONAL ELEMENTS
      DIAG(J)=A1(N1)
      NCX=NC -ND+1
      DO 36 KKR=1,ND
      REGSS(KKR)=A1(NCX)*B(NCX)+REGSS(KKR)
   36 NCX=NCX+1
      NNC=NC
      NN1=N1
      NNX=NX
      LL2=L2
    1 NN=NN-1
   10 L2=L2+1
      N1=NC+1
    2 NX=NX+1
      NC=NC+NT-NX
      K2=L2
```

```
      DO 8I=N1,NC
      A1(I)=A1(I)-A1(K2)*B(L2)
    8 K2=K2+1
      IF(NC-NOELM)10,11,11
   11 L2=LL2+NN
      NX=NNX+1
      N1=NNC+1
   12 NC=NNC+NT-NX
C     BACK SUBSTITUTION
C
      DO 31 I=1,NOELM
   31 A1(I)=B(I)
      II=0
C     START INVERSE COMPUTATIONS
      NC=NCI-ND
      ERASE(C)
      KK=0
      DO 391I=1,NC
      DO 39 J=I,NC
      KK=KK+1
      D(I,J)=A1(KK)
   39 D(J,I)=D(I,J)
  391 KK=KK+ND
      J=NC
      NN=1
      NO=0
      NM=NC-1
      NX=NC-1
      DO40I=1,NC
   40 C(I,I)=1.0/DIAG(I)
      DO41KK=1,NX
      K=NC-NO
      I=NC-NN
      DO42N=1,NM
      C(I,J)=C(I,J)-D(I,K)*C(K,J)
   42 I=I-1
      NN=NN+1
      NO=NO+1
   41 NM=NM-1
C     START GROUP 2
      NT=NC-3
      NK=1
      MT=NC-2
      N2=2
      DO54MA=1,MT
      NO=0
      J=J-1
      NN=N2
      K=NC-NO
      DO45KZ=1,NK
      C(J,J)=C(J,J)-D(J,K)*C(K,J)
   45 K=K-1
      NK=NK+1
      NM=NC-NT
      K=NC-NO
```

```
      I=NC-NN
      DO50NF=1,NK
      DO49N=1,NM
      C(I,J)=C(I,J)-D(I,K)*C(K,J)
   49 I=I-1
      K=K-1
      NO=NO+1
   50 I=NC-NN
      NN=NN+1
      NM=NM-1
      IF(NM)55,55,53
   53 NR=NX-NK
      DO52KK=1,NR
      K=NC-NO
      I=NC-NN
      DO51N=1,NM
      C(I,J)=C(I,J)-D(I,K)*C(K,J)
   51 I=I-1
      NN=NN+1
      NC=NO+1
   52 NM=NM-1
      NT=NT+1
   54 N2=N2+1
   55 K=2
      J=1
      DO60KZ=1,NK
      C(J,J)=C(J,J)-D(J,K)*C(K,J)
   60 K=K+1
      DO 63 I=1,NC
      DO 63 J=I,NC
   63 C(J,I)=C(I,J)
C     END COMPUTATION OF INVERSE
      DO 64 KK=1,ND
      IB=1
      IEN=NP
      IE=IEN
      K=0
   34 DO 35 I=IB,IE
    4 K=K+1
   35 B(K)=A1(I)
      III=I+II
      B(K+1)=A1(III)
    6 K=K+1
      IEN=IE-IB-1
      IB=IE+ND+1
      IE=IB+IEN
      IF(IEN)14,34,34
   14 N1=1
      M=MM
      NZ=1
      NC=NNC-NP*(ND-1)
      NO=NC
      DO 15I=N1,NJ
      X(I)=B(NO)
    7 NZ=NZ+1
```

```
 15 NC=NO-NZ
    NZ=2
    L=NJ-1
    NA=3
    DO 18J=1,L
    NO=NC-NA
    NC=NO
  9 N1=N1+1
    DO 16I=N1,NJ
    X(I)=X(I)-R(NO)*X(N1-1)
 13 NZ=NZ+1
 16 NO=NO-NZ
 17 NA=NA+1
 19 M=M-1
 18 NZ=NZ-M
    LK=NJ
    DO 20 I=1,NJ
    XO(I)=X(LK)
 20 LK=LK-1
 22 II=II+1
    DF=IDF
    NCT=NCI-ND+1
    NXX=NCI-ND
    CONST=AV(NCT)
    DO 62 I=1,NXX
 62 CONST=CONST-XO(I)*AV(I)
    RSQR=REGSS(KK)/TSS(KK)
    SSE=TSS(KK)-REGSS(KK)
    EMS=SSE/DF
    PRINT 1776,KK
1776 FORMAT(1H1/50B,19HDEPENDENT VARIABLE I2)
    PRINT 1777,IDF,TSS(KK),SSE,EMS,REGSS(KK),RSQR
    PRINT 1888
    DO 65 J=1,NJ
    STDERR=SQRTF(EMS*C(J,J))
    T=XO(J)/STDERR
 65 PRINT1889,J,XO(J),STDERR,T
    PRINT 1788,CONST
 64 CONTINUE
1777 FORMAT(1H /9B,2HDF5B,3HTSS14X,3HSSE14X,3HMSE14X,3HSSR12X,
   18HR SQUARE//6BI5,E15.8,4(2X,E15.8)///////)
1788 FORMAT(1H /10B,11H CONSTANT =E17.9////)
1888 FORMAT(1H /13B,1HB,17B,10HREGRESSION18B,
   114HSTANDARD ERROR18B,10HSTUDENTS T/
   2308,11HCOEFFICIENT///)
1889 FORMAT(13B,I2,3(15B,E15.8)//)
    PRINT 1666
1666 FORMAT(1H1/68H                                                    INVERSE
   1 MATRIX SOLUTION////)
    DO 66J=1,NXX
 66 PRINT 801,(C(I,J),I=1,NXX)
    GO TO 111
 33 TYPE,2000
    STOP
800 FORMAT(I2,I3,I2)
```

```
 801 FORMAT(1B,7E17.9)
1000 FORMAT(I2,8B,I2,8B,I4,6B,I1)
1001 FORMAT(7F10.5)
1002 FORMAT(7F10.5)
2000 FORMAT(8H JOB END)
     END
     END
     JOBEND
```

SAMPLE INPUT & OUTPUT

INPUT TEST DATA

```
            TEST DOOLITTLE METHOD
06          01          77          1
95.987
 166987778 066826433-125134720 000000000 000000000-129941662
 066826433 241148995-047857129 066826433-073171280-304462385
-125134720-047857129 137651808 000000000 000000000 116804144
 000000000 066826433 000000000 074161217-158523880-174520723
 000000000-073171280 000000000-158523880 498759156 479101401
 FINIS
```

DEPENDENT VARIABLE 1

DF	TSS	SSE	MSE	SSR	R SQUARE
7700	0.95987000E 02	-0.12604857E 04	-0.16369944E 00	0.13564727E 04	0.14131837E 02

B	REGRESSION COEFFICIENT	STANDARD ERROR	STUDENTS T
1	-0.68568214E 00	0.00000000E 00	0.00000000E 00
2	-0.34524596E 00	0.00000000E 00	0.00000000E 00
3	-0.60977730E-01	0.26478724E-02	-0.23028954E 02
4	-0.62409480E 00	0.29642471E-01	-0.21054075E 02
5	-0.29091332E 00	0.29642471E-01	-0.98140712E 01

CONSTANT = 0.000000000E 00

INVERSE MATRIX SOLUTION

0.598846222E-03	-0.998389149E-03	-0.156626189E-03	0.437824956E-04	0.155949461E-04
-0.998389149E-03	0.249480300E-02	0.311181558E-03	-0.140021430E-02	0.169152335E-03
-0.156626189E-03	0.311181558E-03	-0.428298861E-04	-0.689338542E-03	0.111144314E-03
0.437824956E-04	-0.140021430E-02	-0.689338542E-03	-0.536761818E-02	0.109832193E-02
0.155949461E-04	0.169152335E-03	0.111144314E-03	0.109832193E-02	0.200731841E-03

AXRS07

GENERAL ROUTINE AXRSO7
ANALYSIS OF VARIANCE
FACTORIAL DESIGN WITH NESTING OPTION

PURPOSE: Analysis of variance for a factorial design

METHOD: Least squares estimates

RESTRICTIONS: 1) There are no missing values

2) Maximum of 1000 words of data (observation)

3) Input to computer on cards - data punched one observation per card. This can be modified by changing format statements in the program.

ACCURACY: Single precision floating point computations truncated to eight significant digits.

TRANSFORMATIONS: There are two transformations available - log and square root - others can be easily inserted upon recompilation of the program.

INPUT:

CARD DECK SETUP:

1. Execute card
2. Binary Decks
3. Jobend card
4. Control card
5. Data deck
6. Finis card

Control Card Format

Beginning in Card Column	Punch
1	No. of Observations
5	Levels of Factor A

Control Card Format (cont'd)

Beginning in Card Column	Punch
7	Levels of Factor B
9	Levels of Factor C
11	Levels of Factor D
13	Levels of Factor E
15	Computational codes
45	Transform Number
46	Run Identification (9 characters)

IF the number of factors in a problem is fewer than 5, punch 1 for the number of levels for each unused factor.

COMPUTATIONAL CODES	Result
3	Means and sums of squares are calculated
2	Sum of squares is calculated
1	Neither means nor sum of squares is calculated

COMPUTATIONAL CODE ORDER

	Card Column		Card Column
1. A	15	13. CD	27
2. B	16	14. CE	28
3. C	17	15. DE	29
4. D	18	16. ABC	30
5. E	19	17. ABD	31
6. AB	20	18. ABE	32
7. AC	21	19. ACD	33
8. AD	22	20. ACE	34
9. AE	23	21. ADE	35
10. BC	24	22. BCD	36
11. BD	25	23. BCE	37
12. BE	26	24. BDE	38

COMPUTATIONAL CODE ORDER (cont'd)

		Card Column			Card Column
25.	CDE	39	28.	ABDE	42
26.	ABCD	40	29.	ACDE	43
27.	ABCE	41	30.	BCDE	44

TRANSFORM CODE:	Result
1	Linear
2	Logs of data are taken before computation
3	Square roots of data are taken before computation

DATA CARDS:

1. Observations are ordered with leftmost factor (A) varying most frequently.

2. Punch one or more words per card depending on format statement in main program deck - (generally set to handle one word per card).

OUTPUT:

1. Complete listing of transformed data by row.

2. Grand Average.

3. Identification number and averages for each combination with Code 3.

4. Each line includes the identification number, number of observations per sum, degrees of freedom*, sum of squares*, degrees of freedom**, sum of squares**, for each combination with code 2 or 3. Identification numbers 31, 32, and 33 do not require code 2 or 3 request.

*The degrees of freedom and associated sum of squares are adjusted only for the grand mean.

**The degrees of freedom and associated sum of squares adjusted for each interaction and the grand mean.

Internal work order and output identification number are:

Identification Number	Combination	Identification Number	Combination
1	A	17	BCD
2	AB	18	C
3	ABC	19	CD
4	ABCD	20	D
5	BCDE	21	AC
6	CDE	22	ACD
7	DE	23	AD
8	E	24	ABD
9	ACDE	25	BE
10	ADE	26	CE
11	AE	27	BDE
12	ABDE	28	BCE
13	ABE	29	BD
14	ABCE	30	ACE
15	B	31	Adjusted Total
16	BC	32	Correction Term
		33	Unadjusted Total

For problems with fewer than five variables duplication of computing may be avoided by using Code 1 for the highest order combination in the problem. Code 1 should additionally be used for all combinations which would have no meaning.

DESCRIPTION & PROGRAM LISTING

```
      NEWSTACK
      COMPILES
      SUBROUTINE PRANOV
C     CORRECT AND PRINT SUM SQUARES AND DEGREES OF FREEDOM IN ANOVA
      DIMENSION SS(33),NO(5),NPS(33),NDF(33),Z(33),AS(33),N(33),A2(33)
      DIMENSION CODE(33)
      COMMON SS,NO,NPS,NDF,CODE
      DO3I=1,33
    3 AS(I)=SS(I)
      ASSIGN 11 TO KON
    4 A=AS(1)
      B=AS(15)
      AB=AS(2)-A-B
      IF(NO(3))40,40,6
    6 C=AS(18)
      AC=AS(21)-A-C
      BC=AS(16)-B-C
      ABC=AS(3 )-AB-BC-AC-A-B-C
      IF(NO(4))40,40,7
    7 D=AS(20)
      AD=AS(23)-A-D
      BD=AS(29)-B-D
      CD=AS(19)-C-D
      ABD=AS(24)-AB-BD-AD-A-B-D
      ACD=AS(22)-AC-CD-AD-A-C-D
      BCD=AS(17)-BC-CD-BD-B-C-D
      ABCD=AS(4)-ABD-ACD-BCD-     ABC-CD-BD-AD-BC-AC-AB-A-B-C-D
      IF(NO(5))40,40,8
    8 E=AS(8)
      AE=AS(11)-A-E
      BE=AS(25)-B-E
      CE=AS(26)-C-E
      DE=AS(7)-D-E
      ABE=AS(13)-AB-BE-AE-A-B-E
      ACE=AS(30)-AC-CE-AE-A-C-E
      ADE=AS(10)-AD-DE-AE-A-D-E
      BCE=AS(27)-BC-CE-BE-B-C-E
      BDE=AS(28)-BD-DE-BE-B-D-E
      CDE=AS(6)-CD-DE-CE-C-D-E
      ABCE=AS(14)-ABE-ACE-BCE-ABC-CE-BE-AE-AC-BC-AB-A-B-C-E
      ABDE=AS(12)-ABE-ADE-BDE-ABD-AB-AD-BD    -AE-BE-DE-A-B-D-E
      ACDE=AS(9)-ACE-ADE-CDE-ACD-AC-AD-CD-AE-CE-DE-A-C-D-E
      BCDE=AS(5)-BCD-BCE-BDE-CDE-BC-BD-CD-BE-CE-DE-B-C-D-E
      ABCDE=AS(31)-ABCE-ABDE-ACDE-BCDE-CDE-BDE-BCE-
     1ADE-ACE-ABE-DE-CE-BE-AE-ABCD-BCD-ACD-ABD-
     2CD-BD-AD-ABC-BC-AC-AB-A-B-C-D-E
   40 Z(1)=A
      Z(2)=AB
      Z(3)=ABC
      Z(4)=ABCD
      Z(5)=BCDE
      Z(6)=CDE
      Z(7)=DE
      Z(8)=E
      Z(9)=ACDF
```

```
      Z(10)=ADF
      Z(11)=AE
      Z(12)=ABDE
      Z(13)=ABF
      Z(14)=ABCE
      Z(15)=B
      Z(16)=BC
      Z(17)=BCD
      Z(18)=C
      Z(19)=CD
      Z(20)=D
      Z(21)=AC
      Z(22)=ACD
      Z(23)=AD
      Z(24)=ABD
      Z(25)=BE
      Z(26)=CE
      Z(27)=BCE
      Z(28)=BDE
      Z(29)=BD
      Z(30)=ACE
      Z(31)=ABCDF
      Z(32)=SS(32)
      Z(33)=SS(33)
      GO TO KON,(11,12)
   11 DO 10J=1,33
      AS(J)=NDF(J)
   10 A2(J)=Z(J)
      ASSIGN 12 TO KON
      GO TO 4
   12 DO 13 J=1,33
   13 N(J)=Z(J)
      PRINT2009
   90 DO 951=1,30
      IF(NPS(I))95,95,96
   96 PRINT 2000,CODF(I),NPS(I),NDF(I),SS(I),N(I),A2(I)
   95 CONTINUE
      PRINT 2400,NPS(31),NDF(31),SS(31),N(31),A2(31)
      PRINT 2401,NPS(32),NDF(32),SS(32),N(32),A2(32)
      PRINT 2402,NPS(33),NDF(33),SS(33),N(33),A2(33)
 2400 FORMAT(8X15HADJUSTED TOTAL 12B13,12B13,F17.7,6X13,F17.7)
 2401 FORMAT(7X16HCORRECTION TERM 12X13,12X13,F17.7,6X13,F17.7)
 2402 FORMAT(6X17HUNADJUSTED TOTAL 12X13,12X13,F17.7,6X13,F17.7)
      RETURN
 2009 FORMAT(1H1/93H                                        NUMBER OF    DEGREES
     1 OF       SUM OF    DEGREES OF       SUM OF/
     294H         SOURCE OF VARIATION   OBSERVATIONS     FREEDOM        SQ
     3UARES     FREEDOM        SQUARES///)
 2000 FORMAT(14BA8,12B13,12B,13,F17.7,6B13,F17.7)
      END
      END
      JOBEND
      COMPILEX
TITLEAXRS07
      COMMON SS,NO,NPS,NDF,CODE
```

```
C          . FACTORIAL ANALYSIS OF VARIANCE.
C  MAXIMUM FIVE FACTORS.
      DIMENSION SS(33),NO(5),NSER(30)
      DIMENSION X(1000),NPS(33),NDF(33)
      DIMENSION TITLE(10),CODE(33)
      READ 4400,CODE
 4400 FORMAT(20A4)
  301 READ 4002,TITLE
 4002 FORMAT(10A8)
      IF END OF FILE 333,208
  333 TYPE,2001
      STOP
  208 READ2005,N,NO(1),NO(2),NO(3),NO(4),NO(5),
     1NSER(1),NSER(15),NSER(18),NSER(
     120),NSER(8),NSER(2),NSER(21),NSER(23),NSER(11),
     2NSER(16),NSER(29),NSER(25),NSER(19),NSER(26),
     3NSER(7),NSER(3),NSER(24),NSER(13),NSER(22),
     4NSER(30),NSER(10),NSER(17),NSER(27),NSER(28),
     5NSER(6),NSER(4),NSER(14),NSER(12),NSER(9),NSER(5)
     6,NTRAN
  209 DO 215 I=1,33
      NPS(I)=0
      NDF(I)=0
  215 SS(I)=0.
      FN=N
      SUM=0.
      DO 203 I=1,N
      READ2006,X(I)
  303 GO TO (203,307,306),NTRAN
  307 X(I)=LOGF(X(I))*.434294481
      GO TO 203
  306 X(I)=SQRTF(X(I))
  203 SUM=SUM+X(I)
      PRINT 2555,TITLE
 2555 FORMAT(1H1/64H                                                FACTORIAL ANALYSIS
     1 OF VARIANCE///10A8//53H                                                PR
     2OGRAM INPUT//)
 2005 FORMAT(I4,5I2,31T1)
      PRINT2010,(X(I),I=1,N)
 2010 FORMAT(10F12.5)
      PRINT 4003
 4003 FORMAT(54H                                                PROGRAM OUTPUT/)
      GAVG=SUM/FN
  229 PRINT2002,GAVG
  230 SS(32)=SUM*GAVG
      NPS(32)=N
      NDF(32)=1
      NDF(31)=N-1
      NPS(33)=1
      NDF(33)=N
      DO 204 I=1,N
      X(I)=X(I)-GAVG
  204 SS(31)=SS(31)+X(I)*X(I)
      SS(33)=SS(32)+SS(31)
C  SETUP LOOPS FOR A,AB,ABC,ABCD.
```

```
      JUMP=1
      IOUT=1
      IBACK=1
      I2=1
      I3=1
      JADD=N-1
      JPS=N
      DO 1 NS=1,4
      I2=I2*NO(NS)
      J3=I2
      JPS=JPS/NO(NS)
      NTEST=NSER(NS)
      GO TO (1,2,3),NTEST
    2 NPS(NS)=JPS
      GO TO 4
    1 CONTINUE
C   SETUP LOOPS FOR BCDE,CDE,DE,E.
      IOUT=IOUT+1
      IBACK=IBACK+1
      I3=1
      J3=1
      I2=N
      DO 5 NS=5,8
      I3=I3*NO(NS-4)
      JPS=I3
      NTEST=NSER(NS)
      GO TO (5,6,3),NTEST
    6 JADD=I3-1
      NPS(NS)=JPS
      GO TO 4
    5 CONTINUE
      GO TO 7
C   SUMMATION LOOPS FOR A,AB,ABC,ABCD,BCDE,CDE,DE,E.
    4 DO 8 I=1,I2,I3
      SUM=0.
      J2=I+JADD
      DO 9 J=I,J2,J3
    9 SUM=SUM+X(J)
      GO TO 101
    8 CONTINUE
      GO TO (1,5),IBACK
C   SETUP LOOPS FOR ACDE,ADE,AE.
    7 IBACK=1
      JUMP=JUMP+1
      IOUT=IOUT+1
      K3=NO(1)
      JADD=K3-1
      I3=NO(1)
      JPS=1
      DO 10 NS=9,11
      I3=I3*NO(NS-7)
      JPS=JPS*NO(NS-7)
      NTEST=NSER(NS)
      GO TO(10,11,3),NTEST
   11 KADD=I3-1
```

```
      NPS(NS)=JPS
      GO TO 12
   10 CONTINUE
C  SETUP LOOPS FOR ABDE,ABE.
      IBACK=IBACK+1
      IOUT=IOUT+1
      K3=NO(1)*NO(2)
      JADD=K3-1
      I3=K3
      JPS=1
      DO 13 NS=12,13
      JPS=JPS*NO(NS-9)
      I3=I3*NO(NS-9)
      NTEST=NSER(NS)
      GO TO(13,14,3),NTEST
   14 KADD=I3-1
      NPS(NS)=JPS
      GO TO 12
   13 CONTINUE
C  SETUP FOR ABCF.
      IOUT=IOUT+1
      IBACK=IBACK+1
      NS=14
      NTEST=NSER(14)
      GO TO (15,16,3),NTEST
   16 I3=N/NO(5)
      KADD=I3-1
      K3=I3/NO(4)
      JADD=K3-1
      JPS=NO(4)
      NPS(14)=JPS
C  SUMMATION LOOPS FOR ACDE,ADE,AE,ABDE,ABE,ABCE.
   12 DO 17 I=1,N,I3
      J2=I+JADD
      DO 17 J=I,J2
      SUM=0.
      K2=J+KADD
      DO 18 K=J,K2,K3
   18 SUM=SUM+X(K)
      GO TO 101
   17 CONTINUE
      GO TO(10,13,15),IBACK
C  SETUP LOOPS FOR B,BC,BCD.
   15 IBACK=1
      JUMP=JUMP+1
      IOUT=IOUT+1
      JPS=N
      I3=NO(1)
      I2=NO(1)
      KADD=I3-1
      DO 19 NS=15,17
      JPS=JPS/NO(NS-13)
      I2=I2*NO(NS-13)
      NTEST=NSER(NS)
      GO TO(19,20,3),NTEST
```

```
   20 NPS(NS)=JPS
      GO TO 21
   19 CONTINUE
C  SETUP LOOPS FOR C,CD.
      IBACK=IBACK+1
      IOUT=IOUT+1
      JPS=N
      I3=NO(1)*NO(2)
      I2=I3
      KADD=I3-1
      DO 22 NS=18,19
      JPS=JPS/NO(NS-15)
      I2=I2*NO(NS-15)
      NTEST=NSER(NS)
      GO TO(22,23,3),NTEST
   23 NPS(NS)=JPS
      GO TO 21
   22 CONTINUE
C  SETUP FOR D.
      IBACK=IBACK+1
      IOUT=IOUT+1
      NS=20
      NTEST=NSER(20)
      GO TO(24,25,3),NTEST
   25 I3=NO(1)*NO(2)*NO(3)
      I2=I3*NO(4)
      KADD=I3-1
      NPS(20)=N/NO(4)
       JPS=NPS(20)
C  SUMMATION LOOPS FOR B,BC,BCD,C,CD,D.
   21 DO 26 I=1,I2,I3
      SUM=0.
      DO 27 J=I,N,I2
      K2=J+KADD
      DO 27 K=J,K2
   27 SUM=SUM+X(K)
      GO TO 101
   26 CONTINUE
      GO TO(19,22,24),IBACK
C  SETUP LOOPS FOR AC,ACD.
   24 IBACK=1
      IOUT=IOUT+1
      JUMP=JUMP+1
      L3=NO(1)
      I3=NO(1)*NO(2)
      I2=I3
      LADD=I3-1
      KADD=N-1
      JADD=L3-1
      J3=1
      JPS=N/NO(1)
      DO 28 NS=21,22
      JPS=JPS/NO(NS-18)
      I2=I2*NO(NS-18)
      NTEST=NSER(NS)
```

```
      GO TO(28,29,3),NTEST
   29 NPS(NS)=JPS
      K3=I2
      GO TO 30
   28 CONTINUE
C  SETUP FOR AD,ABD.
      IBACK=IBACK+1
      IOUT=IOUT+1
      I3=NO(1)*NO(2)*NO(3)
      I2=I3*NO(4)
      K3=I2
      J3=1
      KADD=N-1
      LADD=I3-1
      L3=1
      JPS=N/NO(4)
      DO 31 NS=23,24
      L3=L3*NO(NS-22)
      JPS=JPS/NO(NS-22)
      NTEST=NSER(NS)
      GO TO(31,32,3),NTEST
   32 NPS(NS)=JPS
      JADD=L3-1
      GO TO 30
   31 CONTINUE
C  SETUP FOR BE,CE.
      IBACK=IBACK+1
      IOUT=IOUT+1
      I2=N
      I3=N/NO(5)
      L3=1
      KADD=I3-1
      J3=1
      K3=NO(1)
      JPS=NO(1)*NO(3)*NO(4)
      DO 33 NS=25,26
      K3=K3*NO(NS-23)
      J3=J3*NO(NS-24)
      NTEST=NSER(NS)
      GO TO(34,35,3),NTEST
   35 NPS(NS)=JPS
      JADD=K3-1
      LADD=J3-1
      GO TO 30
   34 JPS=NO(1)*NO(2)*NO(4)
   33 CONTINUE
C  SETUP FOR BCE,BDE.
      IBACK=IBACK+1
      IOUT=IOUT+1
      I2=N
      J3=NO(1)
      LADD=J3-1
      L3=1
      K3=NO(1)
      I3=NO(1)*NO(2)
```

```
      JPS=NO(1)*NO(3)
      DO 36 NS=27,28
      I3=I3*NO(NS-24)
      K3=K3*NO(NS-25)
      NTEST=NSER(NS)
      GO TO(37,38,3),NTEST
   38 NPS(NS)=JPS
      JADD=K3-1
      KADD=I3-1
      GO TO 30
   37 JPS=NO(1)*NO(4)
   36 CONTINUE
      GO TO 41
C  SUMMATION LOOPS FOR AC,ACD,AD,ABD,BF,CE,BCE,BDE.
   30 DO 39 I=I1,I2,I3
      J2=I+JADD
      DO 39 J=I,J2,J3
      SUM=0.
      K2=J+KADD
      DO 40 K=J,K2,K3
      L2=K+LADD
      DO 40 L=K,L2,L3
   40 SUM=SUM+X(L)
      GO TO 101
   39 CONTINUE
      GO TO(28,31,34,37),IBACK
C  SETUP AND SUMMATION FOR BD.
   41 JUMP=JUMP+1
      IOUT=IOUT+1
      NS=29
      NTEST=NSER(29)
      GO TO(42,43,3),NTEST
   43 J3=NO(1)
      L3=NO(1)*NO(2)
      I3=L3*NO(3)
      I2=I3*NO(4)
      JADD=L3-1
      LADD=I3-1
      MADD=J3-1
      NPS(29)=NO(1)*NO(3)*NO(5)
      JPS=NPS(29)
      DO 44 I=I1,I2,I3
      J2=I+JADD
      DO 44 J=I,J2,J3
      SUM=0.
      DO 45 K=J,N,I2
      L2=K+LADD
      DO 45 L=K,L2,L3
      M2=L+MADD
      DO 45 M=L,M2
   45 SUM=SUM+X(M)
      GO TO 101
   44 CONTINUE
C  SETUP AND SUMMATION FOR ACE.
   42 IOUT=IOUT+1
```

```
      JUMP=JUMP+1
      NS=30
      NTEST=NSER(30)
      GO TO(46,47,3),NTEST
   47 M3=NO(1)
      J3=NO(1)*NO(2)
      L3=J3*NO(3)
      I3=L3*NO(4)
      JADD=L3-1
      KADD=M3-1
      LADD=I3-1
      MADD=J3-1
      NPS(30)=NO(2)*NO(4)
      JPS=NPS(30)
      DO 48 I=1,N,I3
      J2=I+JADD
      DO 48 J=I,J2,J3
      K2=J+KADD
      DO 48 K=J,K2
      SUM=0.
      L2=K+LADD
      DO 49 L=K,L2,L3
      M2=L+MADD
      DO 49 M=L,M2,M3
   49 SUM=SUM+X(M)
      GO TO 101
   48 CONTINUE
   46 CONTINUE
      DO 95 I=1,30
      IF(NPS(I))95,95,96
   96 NDF(I)=N/NPS(I)-1
   95 CONTINUE
      CALL PRANOV
      GO TO 301
C  COMPUTE AVERAGES AND SUMS OF SQUARES.
  101 RECIP=JPS
      RECIP=1./RECIP
      AVG=SUM*RECIP
      SS(NS)=SS(NS)+SUM*AVG
      GO TO (102,102,103),NTEST
  103 AVG=AVG+GAVG
  105 PRINT2032,AVG
  102 GO TO(8,17,26,39,44,48),JUMP
C  IDENTIFY AVERAGES BY CODE NUMBER.
    3 PRINT 2003, CODE(NS)
      IF(IOUT-9)106,106,107
  106 GO TO(2,6,11,14,16,20,23,25,29),IOUT
  107 IOUT2=IOUT-9
      GO TO(32,35,38,43,47),IOUT2
 2000 FORMAT(3I10,F16.5)
 2001 FORMAT(8HJOB  END)
 2002 FORMAT(5X11H GRAND MEAN/F16.5)
 2003 FORMAT(4XA8)
 2006 FORMAT(F12.5)
 2032 FORMAT(F16.5)
      END
      END
      OVERLAY
      STACKPRANOV
      JOB END
```

SAMPLE INPUT & OUTPUT

INPUT TEST DATA

```
   A  AB ABCABCDBCDE CDE  DE   EACDE ADE  AEABDE ABEABCE   B  BC BCD   C  CD   D
  AC ACD  AD ABD  BE  CE BDE  BCE BD ACE
  TEST PROBLEM 6-8
00600205030201333313331331311331311311111311111
122.
110.
108.
85.
108.
60.
66.
50.
80.
60.
332.
330.
276.
310.
248.
295.
248.
275.
276.
310.
640.
500.
612.
500.
543.
450.
612.
610.
696.
610.
192.
170.
136.
130.
```

```
122.
85.
108.
75.
136.
75.
386.
365.
333.
330.
318.
330.
472.
350.
499.
390.
810.
725.
779.
670.
810.
750.
893.
890.
1820.
890.
 FINIS

CARDS  572
```

FACTORIAL ANALYSIS OF VARIANCE

TEST PROBLEM 6-8

PROGRAM INPUT

122.00000	110.00000	108.00000	85.00000	108.00000	60.00000	66.00000	50.00000	80.00000	60.00000
332.00000	330.00000	276.00000	310.00000	248.00000	295.00000	248.00000	275.00000	276.00000	310.00000
640.00000	500.00000	612.00000	500.00000	543.00000	450.00000	612.00000	610.00000	696.00000	610.00000
192.00000	170.00000	136.00000	130.00000	122.00000	85.00000	108.00000	75.00000	136.00000	75.00000
386.00000	365.00000	333.00000	330.00000	318.00000	330.00000	472.00000	350.00000	499.00000	390.00000
810.00000	725.00000	779.00000	670.00000	810.00000	750.00000	893.00000	890.00000	1820.00000	890.00000

PROGRAM OUTPUT

GRAND MEAN
392.68333
A
426.03333
359.33333
AB
413.66667
366.66667
374.00000
337.50000
358.16667
328.33333
399.83333
375.00000
584.50000
389.16667
ABC
157.00000
140.00000
122.00000
107.50000
115.00000
72.50000
87.00000
62.50000
108.00000
67.50000
359.00000
347.50000
304.50000
320.00000
283.00000
312.50000
360.00000
312.50000
387.50000
350.00000
725.00000
612.50000
695.50000

585.00000
676.50000
600.00000
752.50000
750.00000
1258.00000
750.00000
ABCD
122.00000
110.00000
108.00000
85.00000
108.00000
60.00000
66.00000
50.00000
80.00000
60.00000
332.00000
330.00000
276.00000
310.00000
248.00000
295.00000
248.00000
275.00000
276.00000
310.00000
640.00000
500.00000
612.00000
500.00000
543.00000
450.00000
612.00000
610.00000
696.00000
610.00000
192.00000
170.00000
136.00000
130.00000
122.00000
85.00000
108.00000
75.00000
136.00000
75.00000
386.00000
365.00000
333.00000
330.00000
318.00000
330.00000
472.00000
350.00000

499.00000
390.00000
810.00000
725.00000
779.00000
670.00000
810.00000
750.00000
893.00000
890.00000
1820.00000
890.00000
B
390.16667
355.75000
343.25000
387.41667
486.83333
BC
148.50000
114.75000
93.75000
74.75000
87.75000
353.25000
312.25000
297.75000
336.25000
368.75000
668.75000
640.25000
638.25000
751.25000
1004.00000
BCD
116.00000
96.50000
84.00000
58.00000
70.00000
331.00000
293.00000
271.50000
261.50000
293.00000
570.00000
556.00000
496.50000
611.00000
653.00000
181.00000
133.00000
103.50000
91.50000
105.50000
375.50000

331.50000
324.00000
411.00000
444.50000
767.50000
724.50000
790.00000
891.50000
1355.00000
C
103.90000
333.65000
740.50000
CD
84.90000
290.00000
577.30000
122.90000
377.30000
903.70000
D
317.40000
467.96667
AC
117.80000
90.00000
338.80000
328.50000
821.50000
659.50000
ACD
96.80000
73.00000
276.00000
304.00000
620.60000
534.00000
138.80000
107.00000
401.60000
353.00000
1022.40000
785.00000
AD
331.13333
303.66667
520.93333
415.00000
ARD
364.66667
313.33333
332.00000
298.33333
299.66667
268.33333
308.66667

311.66667
350.66667
326.66667
462.66667
420.00000
416.00000
376.66667
416.66667
388.33333
491.00000
438.33333
818.33333
451.66667
50
339.00000
315.16667
284.00000
310.16667
338.66667
441.33333
396.33333
402.50000
464.66667
635.00000

SOURCE OF VARIATION	NUMBER OF OBSERVATIONS	DEGREES OF FREEDOM	SUM OF SQUARES	DEGREES OF FREEDOM	SUM OF SQUARES
A	30	1	66733.3499700	1	66733.3499700
AB	6	9	282081.4832000	4	62875.9003000
ABC	2	29	4862948.4680000	8	99749.6910000
ABCD	1	59	5833180.9560000	8	87908.2305000
B	12	4	152472.2330000	4	152472.2330000
BC	4	14	4564708.2250000	8	255092.3700000
BCD	2	29	5343804.4680000	8	112781.5585000
C	20	2	4157143.6220000	2	4157143.6220000
CD	10	5	4735154.8740000	2	237956.4355000
D	30	1	340054.8165000	1	340054.8165000
AC	10	5	4292758.2740000	2	68881.3030000
ACD	5	11	4906609.7750000	2	12751.4335000
AD	15	3	429876.9833000	1	23088.8169000
ABD	3	19	800916.3166000	4	67387.7669000
BD	6	9	580830.4826000	4	88303.4331000
ADJUSTED TOTAL	0	59	5833180.9560000	51	5745272.7640000
CORRECTION TERM	60	1	9252012.0150000	012	9252012.0150000
UNADJUSTED TOTAL	1	60	15085192.9700000	192	15085192.9700000

AXRS09

GENERAL ROUTINE AXRS09
STEPWISE MULTIPLE REGRESSION

PURPOSE: To obtain the best fit of a set of observations of independent and dependent variables by an equation of the form

$Y = b_0 + b_1x_1 + b_2x_2 + \cdots\cdots + b_nx_n$ where Y is the dependent variable x_1, x_2, ...are the independent variables; and b_0,b_1, ... are the coefficients to be determined.

This program computes a sequence of multiple linear regression equations in a stepwise manner. At each step one variable is added to the regression equation. The variable added is the one which makes the greatest reduction in the error sum of squares. Equivalently it is the variable which has highest partial correlation with the dependent variable partialed on the variables which have already been added; and equivalently it is the variable which if it were added would have the highest F value. Variables can be added to the regression equation and automatically removed when their F values become too low. Regression equations with or without the regression intercept may be selected.

RESTRICTIONS: 1) A maximum of 30 variables (independent plus dependent) can be treated in each run.

2) Input to computer is on cards

ACCURACY: Single precision floating point computations with eight significant digits.

OPTIONS: Transformation of any variable can be made by inserting the proper automath statements between the two transform comment cards in the source program deck (i.e., X(1) = LOGF X(1) or X(6) = SQRTF (X(6)) or X(13) = A + B * X(13) where A and B have been defined on preceding transform cards.

INPUT: Data may be punched on cards in any format which can be suitably described by the Automath Format statement. The standard card format is seven fields of ten digits each; the last 10 digits may be used for identification.

CARD DECK SETUP:

1. Compilex card
2. Program source deck - complete with modified Format statement (#1001), Transform Statements, overlay card, Binary Subroutine Decks and Jobend card.
3. Name Card - describes run-uses card columns 2-80
4. Control card

Parameter	Card Column
No. of variables (NCI) (Max 30)	1-2
1 + degrees of freedom for error for matrix calculated from Residual SS- otherwise use the count (DEFR) observations	3-6
Tolerance - usually .001 (TOL)	7-12
F - Level for entering a variable (EFIN)	13-18
F - Level for dropping a variable EFOUT maybe _F-level for entering	19-24

5. Data - Cards punched in most any form can be handled by this program (several variables per card or one per card) and is described by a FORMAT statement included in the program source deck.
6. Finis card
7. Repeat steps 3-6 for each additional run.
8. FINIS card

*Note: When generating additional variables (transforms) allow for reading them in the FORMAT statement.

DESCRIPTION & PROGRAM LISTING

```
      NEWSTACK
      COMPILES
      SUBROUTINE CORR3
      COMMON A1,SS,AVG,NCI
      COMMON DEFR,TOL,EFIN,EFOUT,AN
      DIMENSION A1(465),AVG(30),SS(30),R(465)
C     COMPUTATION OF CORRELATION MATRIX
      PRINT1222
      NC=NCI
      NCO=NC
      K=1
      NCA=0
      N1=1
      NE=1
      DO 456 L=1,NC
      DO 454 I=N1,NCO
      R(I)=A1(I)/SQRTF(A1(N1)*A1(K))
      K=K+NCO-NCA
  454 NCA=NCA+1
C     PULL SUM SQUARES
      SS(L)=A1(N1)
      N1=NCO+1
      K=N1
      NCO=NCO+NC-NE
  456 NE=NE+1
      N1=1
      NN=NCI
      NE=1
      DO 6 K=1,NCI
      PRINT1998,K
      PRINT2000,(R(I),I=N1,NN)
      DO 7 J=N1,NN
    7 A1(J)=R(J)
      N1=NN+1
      NN=NN+NCI-NE
    6 NE=NE+1
      RETURN
 1998 FORMAT(5H ROW I2)
 2000 FORMAT(1P,7E17.9//)
 1222 FORMAT(1H1/79H                                                  MATRIX OF SIMP
     1LE CORRELATION COEFFICIENTS////)
      END
      END
      JOBEND
      COMPILES
      SUBROUTINE STEP
      COMMON A1,SS,AVG,NCI
      COMMON DEFR,TOL,EFIN,EFOUT,AN
      DIMENSION A1(465),AVG(30),SS(30),A(30,30),INDEX(30),COEFN(30),
     1SIGCO(30)
      NC=NCI
      KK=0
      DO61=1,NC
    6 SS(I)=SQRTF(SS(I))
      DO4I=1,NC
```

```
      DO4J=1,NC
   27 KK=KK+1
      A(I,J)=A1(KK)
    4 A(J,I)=A(I,J)
      DEFR=DEFR-1.0
      NOVMI=NC-1
      NOENT=0
      NSTEP=-1
 1000 NSTEP=NSTEP+1
      SIGY=SQRTF(A(NC,NC)/DEFR)*SS(NC)
      DEFR=DEFR-1.0
      IF(DEFR)1017,1017,1020
C     OUTPUT NO.1,DEGREES OF FREEDOM REDUCED TO ZERO
 1017 PRINT100,NSTEP,DEFR
      GO TO 1580
 1020 VMIN=0.0
      VMAX=0.0
      NOIN=0
      DO1050I=1,NOVMI
      IF(A(I,I))1042,1050,1060
C     OUTPUT NO.2,R(I,I) IS NEGATIVE MAJOR DIAGONAL
 1042 PRINT200,NSTEP,I
      GO TO 1580
 1060 IF(A(I,I)-TOL)1050,1050,1080
 1080 VAR=A(I,NC)*A(NC,I)/A(I,I)
      IF(VAR)1100,1050,1110
 1100 NOIN=NOIN+1
      INDEX(NOIN)=I
      COEFN(NOIN)=A(I,NC)*SS(NC)/SS(I)
      SIGCO(NOIN)=SQRTF(A(I,I))*SIGY/SS(I)
      IF(VMIN)1160,1170,904
C     OUTPUT NO.3,VMIN IS POSITIVE,PROG RESETS
  904 PRINT300,VMIN
      RETURN
 1170 VMIN=VAR
      NOMIN=I
      GO TO 1050
 1160 IF(VAR-VMIN)1050,1050,1170
 1110 IF(VAR-VMAX)1050,1050,1210
 1210 VMAX=VAR
      NOMAX=I
 1050 CONTINUE
      IF(NOIN)903,1240,1250
C     ERROR-NOIN IS NEGATIVE
  903 RETURN
C     OUTPUT,5,STANDARD DEVIATION OF Y
 1240 PRINT400,SIGY
      GO TO 1350
 1250 CNST=AVG(NC)
      DO1280I=1,NOIN
      J=INDEX(I)
 1280 CNST=CNST-COEFN(I)*AVG(J)
      M=1
 1310 IF(NOENT)1311,1311,1313
C     OUTPUT,6,VARIABLE K REMOVED, PRINT STEP NO.,
```

```
C      K,FLEVL,S.D.OF Y,CONSTANT,I-R2
 1311 PRINT500,NSTEP,K
      GO TO 20
C      OUTPUT.7. VARIABLE K ENTERED. PRINT 6
 1313 PRINT500,NSTEP,K
   20 PRINT600,FLEVL,SIGY,CNST,A(NC,NC)
      DO9J=1,NOIN
    9 PRINT700,INDEX(J),COEFN(J),SIGCO(J)
      GO TO(1320,1580),M
 1320 FLEVL =VMIN*DEFR/A(NC,NC)
      IF(EFOUT+FLEVL)1350,1350,1340
 1340 K=NOMIN
      NCENT=0
      GO TO 1391
 1350 FLEVL =VMAX *DEFR/(A(NC,NC)-VMAX)
      IF(EFIN-FLEVL )1370,1370,1380
 1370 K=NOMAX
      NCENT=K
 1391 IF(K)1392,1392,1400
 1392 PRINT500,NSTEP,K
      RETURN
 1400 DO1410I=1,NC
      IF(I-K)1430,1410,1430
 1430 DO1440J=1,NC
      IF(J-K)1460,1440,1460
 1460 A(I,J)=A(I,J)-A(I,K)*A(K,J)/A(K,K)
 1440 NC=NC
 1410 NC=NC
      DO1480I=1,NC
      IF(I-K)1500,1480,1500
 1500 A(I,K)=-A(I,K) /A(K,K)
 1480 CONTINUE
      DO1520J=1,NC
      IF(J-K)1540,1520,1540
 1540 A(K,J)=A(K,J)/A(K,K)
 1520 CONTINUE
      A(K,K)=1.0/A(K,K)
      GO TO 1000
 1380 PRINT900,NSTEP
      M=2
      GO TO 1310
 1580 PRINT102
      PRINT 101,(J,A(J,J),J=1,NC)
      RETURN
  100 FORMAT(1H,I2,E17.9)
  101 FORMAT(8H,I2,15H,E16.9)
  102 FORMAT(27H           DIAGONAL ELEMENTS//34H      VAR.NO.
     1     VALUE//)
  200 FORMAT(1H,I2,3H,I3)
  300 FORMAT (1H,E17.9)
  400 FORMAT(30H          STANDARD ERROR OF Y =E16.9)
  500 FORMAT(17H       STEP NO.   I3/29H          VARIABLE ENTERING   I2)
  600 FORMAT(21H          F LEVEL     E16.9/30H          STANDARD ERROR OF
     1 Y =E16.9/22H          CONSTANT     E16.9/15H          CORR =E16.9/)
  700 FORMAT(88H                                VARIABLE        COEFFICIENT
```

```
     1         STD ERROR OF COEFFICIENT/33H
     2X= I2,9B,E16.9,9B,E16.9)
  900 FORMAT(1B,I2)
      END
      END
      JOBEND
      COMPILEX
 TITLEAXRS09
C     STEP WISE MULTIPLE REGRESSION
      COMMON A1,SS,AVG,NCI
      COMMON DEFR,TOL,EFIN,EFOUT,AN
      DIMENSION TITLE(10)
      DIMENSION A1(465),AVG(30),SS(30),X(30)
  100 REWIND 6
      PRINT 2003
 2003 FORMAT(1H1)
      READ 2002,TITLE
      PRINT2002,TITLE
 2002 FORMAT(10A8)
C     COMPUTATION OF CORRELATION MATRIX
      READ 1000,NCI,DEFR,TOL,EFIN,EFOUT
 1000 FORMAT(I2,F4.0,3F6.3)
 1001 FORMAT(F5.2,F5.0,2F5.2,2F5.0)
      IF END OF FILE 25,30
   30 NC=NCI
      NOELM=NC*(NC+1)/2
      ERASE((A1(K),K=1,NOELM))
      AN=0.0
    1 READ1001,(X(I),I=1,NC)
      IF END OF FILE 4,2
    2 NC=NC
C     INSERT TRANSFORMS HERE
C     END OF TRANSFORMS
      DO 3 I=1,NC
    3 A1(I)=A1(I)+X(I)
      AN=AN+1.0
      WRITE TAPE 6,(X(I),I=1,NC)
      GO TO 1
    4 END FILE 6
      REWIND 6
      DO 5 I=1,NC
    5 AVG(I)=A1(I)/AN
      PRINT 1003,NCI,DEFR,EFIN,EFOUT
 1003 FORMAT(31H          NUMBER OF VARIABLES   I2/27H          DEGREES OF
     U FREEDOMF4.0/37H          F LEVEL TO ENTER VARIABLE   E16.9/38H
     1     F LEVEL TO REMOVE VARIABLE   E16.9//)
      PRINT 2011
 2011 FORMAT(1H0///60H
     1     SUMS //)
      PRINT 2000,(A1(I),I=1,NC)
      PRINT 2010
 2010 FORMAT(1H0///60H
     1     MEANS//)
      PRINT 2000,(AVG(I),I=1,NC)
      PRINT2020
```

```
2020 FORMAT(1H0///69H                                                  BER
    1BER OF OBSERVATIONS//)
     PRINT3000,AN
3000 FORMAT(56B,F5.0)
     ERASE((A1(K),K=1,NOELM))
   8 READ TAPE 6,(X(I),I=1,NC)
     IF END OF FILE41,6
   6 NN=1
     II=1
     K=1
     DO9I=II,NC
     TEMP=X(I)-AVG(I)
     DO 7 J=NN,NC
     A1(K)=TEMP*(X(J)-AVG(J))+A1(K)
   7 K=K+1
     NN=NN+1
   9 II=NN
     GO TO 8
  41 PRINT1111
1111 FORMAT(1H0/82H                                  SUM OF SQUARES OF
    1 DEVIATIONS AND CROSS PRODUCTS////)
  45 N1=1
     NN=NCI
     NE=1
     DO46 K=1,NCI
     PRINT1999,K
1999 FORMAT(14H           ROW I2)
  47 PRINT2000,(A1(I),I=N1,NN)
     N1=NN+1
     NN=NN+NCI-NE
  46 NE=NE+1
  15 IND3=0
     NOELM=NOELM+NC*NC
     CALL CORR3
     CALL STEP
     GO TO 100
  25 TYPE,802
     STOP
2000 FORMAT(1B,7E17.9//)
 802 FORMAT(8HTHATS IT)
     END
     END
     OVERLAY
     STACKCORR3
     STACKSTEP
     JCBEND
```

SAMPLE INPUT & OUTPUT

STEPWISE MULTIPLE REGRESSION BIMED TEST EFROYNSON

060068 .001 .5 .3 CONTROL DATA

```
00250000250250000150000340006 4
01300000210210000087000360006 5
00350000220220000043000410008 2

00175000090013000180000150002 3
00300000230230000200000330006 4
00200000100006000330000130001 6
00550000070014000340000160001 2
00600000060008000500000110002 7
00130000080027000150000190004 8
00500000180036000180000270005 0
00500000030010000140000140001 2
00300000080027000100000250001 3
00200000060030000150000210002 0
00200000080010000250000180002 3
00100000220220000110000460011 8
00400000130130000280000170005 0
00050000260012000073000480006 3
00025000230230000010000360015 0
01400000030010000350000050007 2
00250000150025000028000330005 4
00350000280140000001000460010 9
00350000060006000500000100001 0
00250000350350000570000380012 5
00050000110020000340000160004 4
00200000110110000050000200004 8
00700000320320000660000380010 5
00400000080010000450000120000 9
01500000230230000015000490013 0
00100000380380000220000430016 0
00350000150050000150000330004 8
01300000060012000370000090003 6
00200000250250000100000350015 0
01200000050017000030000210007 8
00400000090007500190000170002 3
00300000070035000260000120004 2
00800000200200000220000300007 2
00900000060008600250000150002 0
00600000120040000120000200003 6
00800000260016000110000350005 6
00150000150030000160000290003 6
00700000100009001000000120002 6
00800000280280000420000400010 8
00200000340340000090000420010 6
00600000040008000360000110001 6
01500000320320000180000440010 4
01700000110110000230000140004 7
01600000020005000180000110002 7
00300000180016000110000320001 2
00600000030004000130000150000 7
01400000080011000200000170001 8
00600000140009000070000290002 8
00180000120024000150000210002 5
01500000030015000080000130001 1
01800000060055000570000090002 0
00500000120020000410000160001 4
03000000110110000200000220003 8
02900000080080000100000220010 3
00180000240240000110000380010 6
```

```
0130000026026000017000038000 63
0190000029029000480000029002 08
0110000017017000016000025000 32
0100000015005000035000019000 28
0060000010005000010000026000 32
0050000022022000012000039001 00
0010000150050000080000290005 0
0170000009003000130000010000 80
0050000030035000009000058000 65
0013000010001300090000010000 25
 FINIS


CARDS  344
```

STEPWISE MULTIPLE REGRESSION BIMED TEST EFROYNSON

NUMBER OF VARIABLES 6
DEGREES OF FREEDOM 68.
F LEVEL TO ENTER VARIABLE 0.500000000E 00
F LEVEL TO REMOVE VARIABLE 0.300000000E 00

SUMS

0.475700000E 03 0.103700000E 04 0.708910000E 03 0.210770000E 03 0.172700000E 04 0.386200000E 04

MEANS

0.699558824E 01 0.152500000E 02 0.104251471E 02 0.309955882E 01 0.253970588E 02 0.567941176E 02

BER OF OBSERVATIONS

68.

SUM OF SQUARES OF DEVIATIONS AND CROSS PRODUCTS

ROW 1
0.280793366E 04 -0.716225001E 03 0.258925437E 02 0.664559868E 03 -0.105923088E 04 0.154998824E 04
ROW 2
0.596675000E 04 0.632733248E 04 0.378697500E 03 0.687824998E 04 0.204674999E 05
ROW 3
0.905758106E 04 0.588022755E 03 0.731002101E 04 0.266678320E 05
ROW 4
0.240969168E 04 -0.704198088E 03 0.599451383E 04
ROW 5
0.104342794E 05 0.234965587E 05
ROW 6
0.127073117E 06

MATRIX OF SIMPLE CORRELATION COEFFICIENTS

```
ROW  1
  0.100000000E 01 -0.176464465E 00  0.513422837E-02  0.255481790E 00 -0.195688805E 00  0.820555836E-01
ROW  2
  0.100000000E 01  0.867992055E 00  0.100719349E 00  0.379119542E 00  0.749616545E 00
ROW  3
  0.100000000E 01  0.125865666E 00  0.751937697E 00  0.786058292E 00
ROW  4
  0.100000000E 01 -0.140437430E 00  0.342567679E 00
ROW  5
  0.100000000E 01  0.645167154E 00
ROW  6
  0.100000000E 01
        STANDARD ERROR OF Y = 0.435501284E 02
     STEP NO.      1
        VARIABLE ENTERING     3
        F LEVEL       0.106724064E 03
        STANDARD ERROR OF Y = 0.271237928E 02
        CONSTANT       0.260998222E 02
        CORR = 0.382112362E 00

                              VARIABLE         COEFFICIENT          STD ERROR OF COEFFICIENT
                               X-  3           0.294425540E 01            0.284999634E 00
     STEP NO.      2
        VARIABLE ENTERING     4
        F LEVEL       0.121820955E 02
        STANDARD ERROR OF Y = 0.250821120E 02
        CONSTANT       0.217444916E 02
        CORR = 0.321801363E 00

                              VARIABLE         COEFFICIENT          STD ERROR OF COEFFICIENT
                               X-  3           0.282754921E 01            0.265659659E 00
                              VARIABLE         COEFFICIENT          STD ERROR OF COEFFICIENT
                               X-  4           0.179767834E 01            0.515051891E 00
     STEP NO.      3
        VARIABLE ENTERING     5
        F LEVEL       0.739256605E 01
        STANDARD ERROR OF Y = 0.239328426E 02
        CONSTANT       0.291071750E 01
        CORR = 0.288479437E 00

                              VARIABLE         COEFFICIENT          STD ERROR OF COEFFICIENT
                               X-  3           0.195839757E 01            0.407973952E 00
                              VARIABLE         COEFFICIENT          STD ERROR OF COEFFICIENT
                               X-  4           0.231239125E 01            0.526652073E 00
                              VARIABLE         COEFFICIENT          STD ERROR OF COEFFICIENT
                               X-  5           0.103553033E 01            0.380859873E 00
     STEP NO.      4
        VARIABLE ENTERING     1
        F LEVEL       0.787546375E 00
        STANDARD ERROR OF Y = 0.239726654E 02
        CONSTANT      -0.125284238E 01
```

CORR = 0.284917755E 00

VARIABLE	COEFFICIENT	STD ERROR OF COEFFICIENT
X- 1	0.427207760E 00	0.481394432E 00
VARIABLE	COEFFICIENT	STD ERROR OF COEFFICIENT
X- 3	0.189676592E 01	0.414512080E 00
VARIABLE	COEFFICIENT	STD ERROR OF COEFFICIENT
X- 4	0.223334554E 01	0.534995316E 00
VARIABLE	COEFFICIENT	STD ERROR OF COEFFICIENT
X- 5	0.111674116E 01	0.392315853E 00

4

STEP NO. 4
VARIABLE ENTERING 1
F LEVEL 0.170755077E 00
STANDARD ERROR OF Y = 0.239726654E 02
CONSTANT -0.125284238E 01
CORR = 0.284917755E 00

VARIABLE	COEFFICIENT	STD ERROR OF COEFFICIENT
X- 1	0.427207760E 00	0.481394432E 00
VARIABLE	COEFFICIENT	STD ERROR OF COEFFICIENT
X- 3	0.189676592E 01	0.414512080E 00
VARIABLE	COEFFICIENT	STD ERROR OF COEFFICIENT
X- 4	0.223334554E 01	0.534995316E 00
VARIABLE	COEFFICIENT	STD ERROR OF COEFFICIENT
X- 5	0.111674116E 01	0.392315853E 00

DIAGONAL ELEMENTS

VAR.NO.	VALUE
1	0.113228649E 01
2	0.102907694E 00
3	0.270833309E 01
4	0.120013138E 01
5	0.279448337E 01
6	0.284917755E 00

AXRS14

OUTPUT: 1) Computes and prints a matrix of sums squares deviations and cross products.

2) Computes and prints means and standard deviations of all variables.

3) Computes correlation coefficients of all variables against each other and tabulates them as a triangular matrix.

4) Extracts eigenvalues and eigenvectors from the correlation coefficient matrix.

5) Using the eigenvectors the independent variables are transformed into principal components (which are ordered as to importance and which are not interdependent).

6) Computes by least squares the multiple regression coefficients of each dependent variable versus all of the principal components.

7) Works backwards from the dependent variable versus principal component regression coefficient to get dependent variable versus independent variable regression coefficients and prints one set of coefficients using each additional principal component.

References:

GENERAL ROUTINE AXRS14
PRINCIPAL COMPONENTS ANALYSIS

T. A. Entzminger

PURPOSE: Performs a regression on the principal components of a group of closely related variables.

RESTRICTIONS: 1) A maximum of 20 variables (dependent and independent) can be treated in each run.

2) Input must be on cards.

ACCURACY: Single precision floating point computations with eight significant digits.

INPUT: Data may be punched on cards in any format which can be suitably described by an Automath FORMAT statement. Arrange data so that they are treated by the READ statement in the following manner:

(a) one observation of every variable in each read cycle

(b) observations of all independent variables should precede observations of dependent variables in the same read cycle.

CARD DECK SETUP:

1. Program decks
2. Name cards
3. Control card

	Card Column
Total number of variables	1-2
Number of dependent variables	3-4

4. Data deck
5. FINIS card

DESCRIPTION & PROGRAM LISTING

```
      NEWSTACK
      COMPILES
      SUBROUTINE CORREL
      DIMENSION R(210),A1(210),DIAG(20),U(20,20),SIG(20)
      COMMON A1,NOELM,NCI,ND,DIAG,U,SIG
C     COMPUTATION OF CORRELATION MATRIX
      PRINT1222
      NC=NCI
      NCO=NC
      K=1
      NCA=0
      N1=1
      NE=1
      DO 456 L=1,NC
      DO 454 I=N1,NCO
      R(I)=A1(I)/SQRTF(A1(N1)*A1(K))
      K=K+NCO-NCA
  454 NCA=NCA+1
      N1=NCO+1
      K=N1
      NCO=NCO+NC-NE
  456 NE=NE+1
      N1=1
      NN=NCI
      NE=1
      DO 6 K=1,NCI
      PRINT1998,K
      PRINT2000,(R(I),I=N1,NN)
      N1=NN+1
      NN=NN+NCI-NE
    6 NE=NE+1
      DO 17I=1,NOELM
   17 A1(I)=R(I)
      RETURN
 1998 FORMAT(5H ROW I2)
 2000 FORMAT(1P,7E17.9//)
 1222 FORMAT(1H1/79H                                                    MATRIX OF SIMP
     1LE CORRELATION COEFFICIENTS////)
      END
      END
      JOBEND
```

```
      COMPILES
      SUBROUTINE EIGEN
      DIMENSION H(20,20),U(20,20),X(20),IQ(20),A1(210),DIAG(20),SIG(20
      COMMON A1,NOELM,NCI,ND,DIAG,U,SIG
C     CONSTRUCT SQUARE MATRIX OF INDEPENDENT VARIABLES
      KK=0
      N=NCI-ND
      DO 5I=1,N
      DO4J=I,N
      KK=KK+1
      H(I,J)=A1(KK)
    4 H(J,I)=H(I,J)
    5 KK=KK+ND
   10 DO14I=1,N
      DO14J=1,N
      IF(I-J)12,11,12
   11 U(I,J)=1.0
      GO TO 14
   12 U(I,J)=0.
   14 CONTINUE
   15 NR=0
      IF(N-1)1000,1000,17
   17 NMI1=N-1
      DO30I=1,NMI1
      X(I)=0.
      IPL1=I+1
      DO30J=IPL1,N
      IF(X(I)-ABSF(H(I,J)))20,20,30
   20 X(I)=ABSF(H(I,J))
      IQ(I)=J
   30 CONTINUE
      RAP=7.450580596E-9
      HDTEST=1.0E38
   40 DO70I=1,NMI1
      IF(I-1)60,60,45
   45 IF(XMAX-X(I))60,70,70
   60 XMAX=X(I)
      IPIV=I
      JPIV=IQ(I)
   70 CONTINUE
      IF(XMAX)1000,1000,80
   80 IF(HDTEST)90,90,85
   85 IF(XMAX-HDTEST)90,90,148
   90 HDIMIN=ABSF(H(1,1))
      DO110I=2,N
      IF(HDIMIN-ABSF(H(I,I)))110,110,100
  100 HDIMIN=ABSF(H(I,I))
  110 CONTINUE
      HDTEST=HDIMIN*RAP
      IF(HDTEST-XMAX)148,1000,1000
  148 NR=NR+1
```

```
150 TANG=SIGNF(2.0,(H(IPIV,IPIV)-H(JPIV,JPIV)))*H(IPIV,JPIV)/(ABSF(H(I
   1PIV,IPIV)-H(JPIV,JPIV))+SQRTF((H(IPIV,IPIV)-H(JPIV,JPIV))**2+4.0*H
   2(IPIV,JPIV)**2))
    COSINE=1.0/SQRTF(1.0+TANG**2)
    SINE=TANG*COSINE
    HII=H(IPIV,IPIV)
    H(IPIV,IPIV)=COSINE**2*(HII+TANG*(2.*H(IPIV,JPIV)+TANG*H(JPIV,
   1JPIV)))
    H(JPIV,JPIV)=COSINE**2*(H(JPIV,JPIV)-TANG*(2.*H(IPIV,JPIV)-
   1TANG*HII))
    H(IPIV,JPIV)=0.
    IF(H(IPIV,IPIV)-H(JPIV,JPIV))152,153,153
152 HTEMP=H(IPIV,IPIV)
    H(IPIV,IPIV)=H(JPIV,JPIV)
    H(JPIV,JPIV)=HTEMP
    HTEMP=SIGNF(1.0,-SINE)*COSINE
    COSINE=ABSF(SINE)
    SINE=HTEMP

153 CONTINUE
    DO350I=1,NMI1
    IF(I-IPIV)210,350,200
200 IF(I-JPIV)210,350,210
210 IF(IQ(I)-IPIV)230,240,230
230 IF(IQ(I)-JPIV)350,240,350
240 K=IQ(I)
250 HTEMP=H(I,K)
    H(I,K)=0.
    IPL1=I+1
    X(I)=0.
    DO320J=IPL1,N
    IF(X(I)-ABSF(H(I,J)))300,300,320
300 X(I)=ABSF(H(I,J))
    IQ(I)=J
320 CONTINUE
    H(I,K)=HTEMP
350 CONTINUE
    X(IPIV)=0.
    DO530I=1,N
    IF(I-IPIV)370,530,420
370 HTEMP=H(I,IPIV)
    H(I,IPIV)=COSINE*HTEMP+SINE*H(I,JPIV)
    IF(X(I)-ABSF(H(I,IPIV)))380,390,390
380 X(I)=ABSF(H(I,IPIV))
    IQ(I)=IPIV
390 H(I,JPIV)=-SINE*HTEMP+COSINE*H(I,JPIV)
    IF(X(I)-ABSF(H(I,JPIV)))400,530,530
400 X(I)=ABSF(H(I,JPIV))
    IQ(I)=JPIV
    GOTO530
420 IF(I-JPIV)430,530,480
430 HTEMP=H(IPIV,I)
    H(IPIV,I)=COSINE*HTEMP+SINE*H(I,JPIV)
    IF(X(IPIV)-ABSF(H(IPIV,I)))440,450,450
440 X(IPIV)=ABSF(H(IPIV,I))
    IQ(IPIV)=I
450 H(I,JPIV)=-SINE*HTEMP+COSINE*H(I,JPIV)
    IF(X(I)-ABSF(H(I,JPIV)))400,530,530
```

```
 480 HTEMP=H(IPIV,I)
     H(IPIV,I)=COSINE*HTEMP+  SINE*H(JPIV,I)
     IF(X(IPIV)-ABSF(H(IPIV,I)))490,500,500
 490 X(IPIV)=ABSF(H(IPIV,I))
     IG(IPIV)=I
 500 H(JPIV,I)=-SINE*HTEMP+COSINE*H(JPIV,I)
     IF(X(JPIV)-ABSF(H(JPIV,I)))510,530,530
 510 X(JPIV)=ABSF(H(JPIV,I))
     IG(JPIV)=I
 530 CONTINUE
 540 DO550I=1,N
     HTEMP=U(I,IPIV)
     U(I,IPIV)=COSINE*HTEMP+SINE*U(I,JPIV)
 550 U(I,JPIV)=-SINE*HTEMP+COSINE*U(I,JPIV)
     GOTO40
1000 DO 600I=1,N

 600 DIAG(I)=H(I,I)
     RETURN
     END
     END
     JOBEND
```

```
      COMPILES
      SUBROUTINE REGRES
C     DETERMINATION OF REGRESSION COEFFICIENTS
      DIMENSION X(20),A1(210),B(210),REGSS(10),XD(20),DIAG(20),U(20,20),
     1SIG(20)
      COMMON A1,NOELM,NCI,ND,DIAG,U,SIG
      ERASE(REGSS)
      NC=NCI
    3 M=NC-ND-1
      MM=M
      NP=NC-ND
      NJ=NC-ND
      NQ=NC-ND
      N1=1
      NN=NC+1
      NZ=2
      L2=1
      NT=NC
      NX=0
      DO 12J=N1,NQ
  300 DO 5I=N1,NC
    5 B(I)=A1(I)/A1(N1)
      NCX=NC -ND+1
      DO 36 KKR=1,ND
      REGSS(KKR)=A1(NCX)*B(NCX)+REGSS(KKR)
   36 NCX=NCX+1
      NNC=NC
      NN1=N1
      NNX=NX
      LL2=L2
    1 NN=NN-1
   10 L2=L2+1
      N1=NC+1
    2 NX=NX+1
      NC=NC+NT-NX
      K2=L2
      DO 8I=N1,NC
      A1(I)=A1(I)-A1(K2)*B(L2)
    8 K2=K2+1
      IF(NC-NOELM)10,11,11
   11 L2=LL2+NN
      NX=NNX+1
      N1=NNC+1
   12 NC=NNC+NT-NX
C
C     MULTIPLE CORRELATION COMPUTATION
C
      DO 37 I=1,ND
   37 REGSS(I)=REGSS(I)/X(I)
      PRINT 1555
```

```
      PRINT 801,(REGSS(I),I=1,ND)
C     BACK SUBSTITUTION
C
      DO 31 I=1,NOELM
   31 A1(I)=B(I)
      II=0
      DO 22 KK=1,ND
      IB=1
      IEN=NP
      IE=IEN
      K=0
   34 DO 35 I=IB,IE
    4 K=K+1
   35 B(K)=A1(I)
      III=I+II
      B(K+1)=A1(III)
    6 K=K+1
      IEN=IE-IB-1
      IB=IE+ND+1
      IE=IB+IEN
      IF(IEN)14,34,34
   14 N1=1
      M=MM
      NZ=1
      NC=NNC-NP*(ND-1)
      NO=NC
      DO 15I=N1,NJ
      X(I)=B(NO)
    7 NZ=NZ+1
   15 NO=NO-NZ
      NZ=2
      L=NJ-1
      NA=3
      DO 18J=1,L
      NO=NC-NA
      NC=NO
    9 N1=N1+1
      DO 16I=N1,NJ
      X(I)=X(I)-B(NO)*X(N1-1)
   13 NZ=NZ+1
   16 NO=NO-NZ
   17 NA=NA+1
   19 M=M-1
   18 NZ=NZ-M
      LK=NJ
      DO 20 I=1,NJ
      XO(I)=X(LK)
   20 LK=LK-1
      PRINT1444
      PRINT 801,(XO(I),I=1,NJ)
      ERASE(B)
      DO 78J=1,NJ
      DO 77I=1,NJ
   77 B(I)=XO(J)*U(I,J)/SIG(I)
      PRINT 1445,J
```

```
1445 FORMAT(50B6HUSING I2,21H PRINCIPAL COMPONENTS//)
  78 PRINT 801,(B(I),I=1,NJ)
  22 II=II+1
     RETURN
 800 FORMAT(I2,I3,I2)
1333 FORMAT(1H2/70H                                                    INTE
    1RMEDIATE SOLUTIONS////)
1444 FORMAT(1H2/70H                                                   REGRE
    1SSION COEFFICIENTS////)
1555 FORMAT(1H2/74H                                                MULTIPLE CO
    1RRELATION COEFFICIENTS////)
 801 FORMAT(1P,7E17.9)
     END
     END
     JOBEND
```

```
      COMPILEX
 TITLEAXRS14
C     REGRESSION ON PRINCIPAL COMPONENTS
C     CORRECTED SUMS OF SQUARES AND CROSS PRODUCTS
      COMMON A1,NOELM,NCI,ND,DIAG,U,SIG
      DIMENSION X(20),A1(210),DIAG(20),AVG(20),U(20,20),SIG(20)
      DIMENSION Z(20)
  100 REWIND 6
      REWIND 5
 1001 FORMAT(3F2.1,F3.1)
      READ1000,NCI,ND
      IF END OF FILE 25,30
   30 NC=NCI
      NOELM=NC*(NC+1)/2
      ERASE((A1(K),K=1,NOELM))
      AN=0.0
    1 READ1001,(X(I),I=1,NC)
      IF END OF FILE 4,2
    2 NC=NC
C     INSERT TRANSFORMS HERE
C     END OF TRANSFORMS
      DO 3 I=1,NC
    3 A1(I)=A1(I)+X(I)
      AN=AN+1.0
      WRITE TAPE 6,(X(I),I=1,NC)
      GO TO 1
    4 END FILE 6
      REWIND 6
      ASSIGN8  TO N80
      ASSIGN 15 TO N115
   50 DO 5 I=1,NC
    5 AVG(I)=A1(I)/AN
      ERASE((A1(K),K=1,NOELM))
      GO TO N80,(8,80)
    8 READ TAPE 6,(X(I),I=1,NC)
      IF END OF FILE41,6
    6 NN=1
      II=1
      K=1
      DO9I=II,NC

      TEMP=X(I)-AVG(I)
      DO 7 J=NN,NC
      A1(K)=TEMP*(X(J)-AVG(J))+A1(K)
    7 K=K+1
      NN=NN+1
    9 II=NN
      GO TO N80,(8,80)
   80 READ TAPE 5,(X(I),I=1,NC)
      IF END OF FILE 41,6
   41 PRINT1111
 1111 FORMAT(1H1/82H                                        SUM OF SQUARES OF
     1 DEVIATIONS AND CROSS PRODUCTS////)
   45 N1=1
      NN=NCI
      NE=1
      DO46 K=1,NCI
      PRINT1999,K
 1999 FORMAT(14H           ROW I2)
```

```
  303 A1(I)=A1(I)+Z(I)
      AN=AN+1.0
      WRITE TAPE 5,(Z(I),I=1,NC)
      GO TO 201
  206 END FILE 5
      REWIND 5
      ASSIGN80 TO N80
      ASSIGN 115 TO N115
      GO TO 50
  115 NCELM=N*(N+1)/2+N*ND
      CALL REGRES
      GO TO 100
   25 TYPE,802
      STOP
 1000 FORMAT(2I2)
 2000 FORMAT(1H,7E17.9//)
  802 FORMAT(8HTHATS IT)
      END
      END
      OVERLAY
      STACKCORREL
      STACKEIGEN
      STACKREGRES
      JOBEND
```

SAMPLE INPUT & OUTPUT

INPUT TEST DATA

```
0401
111112223
141511223
171820292
171718270
181918285
181819304
191820311
202121314
232425328

252524340
 FINIS
 FINIS
 FINIS
CARDS  444
```

SUM OF SQUARES OF DEVIATIONS AND CROSS PRODUCTS

ROW 1
0.145600000E 01 0.145800000E 01 0.151400000E 01 0.136600000E 02
ROW 2
0.150400000E 01 0.151200000E 01 0.134100000E 02
ROW 3
0.181600000E 01 0.157700000E 02
ROW 4
0.145540000E 03

STANDARD DEVIATIONS

0.402216083E 00 0.404792259E 00 0.449196814E 00 0.402133201E 01

MEANS

0.182000000E 01 0.186000000E 01 0.188000000E 01 0.289000000E 02

NUMBER OF OBSERVATIONS

10.

MATRIX OF SIMPLE CORRELATION COEFFICIENTS

ROW 1
0.100000000E 01 0.985264689E 00 0.931080574E 00 0.938380181E 00
ROW 2
0.100000000E 01 0.914892455E 00 0.906387014E 00
ROW 3
0.100000000E 01 0.970024238E 00
ROW 4
0.100000000E 01

EIGENVALUES

0.288781538E 01 0.985219262E-01 0.136027204E-01

EIGENVECTORS

0.583211582E 00 0.580007072E 00 0.568731973E 00
0.320839305E 00 0.478736511E 00 -0.817235244E 00
-0.746274976E 00 0.659092579E 00 0.931155594E-01

SUM OF SQUARES OF DEVIATIONS AND CROSS PRODUCTS

ROW 1
0.259903383E 02 -0.290000000E-08 0.260000000E-08 0.587999961E 02
ROW 2
0.886697335E 00 0.107000000E-08 -0.209001885E 01
ROW 3
0.122964483E 00 -0.455014871E 00
ROW 4
0.145540000E 03

MULTIPLE CORRELATION COEFFICIENTS

0.343510491E-15

REGRESSION COEFFICIENTS

0.226237902E 01 -0.235708258E 01 -0.370037643E 01
USING 1 PRINCIPAL COMPONENTS

0.328043979E 01 0.320993316E 01 0.286441765E 01
USING 2 PRINCIPAL COMPONENTS

-0.188019570E 01 -0.273037881E 01 0.428830058E 01
USING 3 PRINCIPAL COMPONENTS

0.686570840E 01 -0.596608904E 01 -0.767063815E 00

AXRS28

GENERAL ROUTINE AXRS28
LINEAR DISCRIMINANT FUNCTION ANALYSIS

T. A. Entzminger

PURPOSE: This program performs calculations which aid in discriminating between two groups of objects or conditions on the basis of several properties of these objects or conditions. The procedure for discriminating consists of finding a critical value of the index such that any object whose index value falls below the critical value is classified as belonging to one group otherwise to the other group.

RESTRICTIONS: A maximum of 10 descriptive variables for each group.

ACCURACY: Single precision floating point computations with eight significant digits.

INPUT: Data may be punched on cards in any format which can be suitably described by the Automath FORMAT statement.

CARD DECK SETUP:

1. Program source deck
2. Control card — Card Column
   Number of variables for discrimination — 1-2
3. Data for group 1 variables
4. Date for group 2 variables
5. Finis card

OUTPUT: The program sets up a two way classification of the data to determine the linear discriminant function Z = f (, x, + 2 x 2 + ... n x n) and prints out Z values for each observation entered along with the coefficients ('s).

REFERENCE: "Introduction to Mathematical Statistics", Paul G. Hoel, 3rd Edition, John Wiley and Sons, Inc., New York.

DESCRIPTION & PROGRAM LISTING

```
      COMPILEX
 TITLEAXRS28
C     LINEAR DISCRIMINANT FUNCTION
      DIMENSION X(10),SUM(66),D(10),DD(10),   B(66),XX(10),XO(10)
      PRINT 5000
 5000 FORMAT(1H1/30X37HLINEAR DISCRIMINANT FUNCTION ANALYSIS//)
      REWIND 6
      READ1000,NV
      NC=NV+1
      NOELM=NC*(NC+1)/2-1
      ERASE((SUM(I),I=1,NV),AN,D,DD)
    1 READ2000,(X(I),I=1,NV)
      IF END OF FILE 5,4
    4 DO 3 I=1,NV
    3 SUM(I)=SUM(I)+X(I)
      AN=AN+1.0
      WRITE TAPE 6,(X(I),I=1,NV)
      GOTO1
    5 END FILE 6
      PRINT 4000,AN
      DO 7 I=1,NV
    7 D(I)=SUM(I)/AN+D(I)
      ERASE((SUM(I),I=1,NV))
      AN=0.0
   11 READ 2001,(X(I),I=1,NV)
      IF END OF FILE 6,10
   10 DO 13 I=1,NV
   13 SUM(I)=SUM(I)+X(I)
      AN=AN+1.0
      WRITE TAPE 6,(X(I),I=1,NV)
      GO TO 11
    6 END FILE 6
      PRINT4001,AN
      REWIND 6
      DO 8 I=1,NV
    8 DD(I)=SUM(I)/AN+DD(I)
      ERASE((SUM(I),I=1,NOELM))
   18 READTAPE6,(X(I),I=1,NV)
      IF END OF FILE 20,16
   16 NN=1
      II=1
      K=1
      DO19I=II,NV
      TEMP=X(I)-D(I)
      DO17J=NN,NV
      SUM(K)=TEMP*(X(J)-D(J))+SUM(K)
   17 K=K+1
      SUM(K)=D(NN)
      K=K+1
      NN=NN+1
   19 II=NN
      GOTO18
   20 READTAPE6,(X(I),I=1,NV)
      IF END OF FILE 31,21
   21 NN=1
```

```
      II=1
      K=1
      DO29I=II,NV
      TEMP=X(I)-DD(I)
      DO27J=NN,NV
      SUM(K)=TEMP*(X(J)-DD(J))+SUM(K)
   27 K=K+1
      SUM(K)=D(NN)-DD(NN)
      K=K+1
      NN=NN+1
   29 II=NN
      GO TO 20
      SIMULTANEOUS EQUATION SOLUTION
   31 M=NC-2
      NJ=NC-1
      NQ=NC-1
      N1=1
      NN=NC+1
      NZ=2
      L2=1
      NT=NC
      NX=0
      DO 120 J=N1,NQ
      DO 50 I=N1,NC
   50 B(I)=SUM(I)/SUM(N1)
      NNC=NC
      NN1=N1
      NNX=NX
      LL2=L2
      NN=NN-1
  100 L2=L2+1
      N1=NC+1
      NX=NX+1
      NC=NC+NT-NX
      K2=L2
      DO 80 I=N1,NC
      SUM(I)=SUM(I)-SUM(K2)*    B(L2)
   80 K2=K2+1
      IF(NC-NOFLM)100,110,110
  110 L2=LL2+NN
      NX=NNX+1
      N1=NNC+1
  120 NC=NNC+NT-NX
  140 N1=1
      NZ=1
      NC=NNC
      NO=NC
      DO 150 I=N1,NJ
      XX(I)=B(NO)
      NZ=NZ+1
  150 NO=NO-NZ
      NZ=2
      L=NJ-1
      NA=3
      DO 180 J=1,L
```

```
      NO=NC-NA
      NC=NO
      N1=N1+1
      DO 160 I=N1,NJ
      XX(I)=XX(I)-B(NO)*XX(N1-1)
      NZ=NZ+1
  160 NO=NO-NZ
      NA=NA+1
      M=M-1
  180 NZ=NZ-M
      REWIND 6
      K=NJ
      PRINT4002
      DO 200 I=1,NJ
      XO(I)=XX(K)
      PRINT801,XO(I)
  200 K=K-1
      PRINT 4003
      XTO=XO(1)
      DO 206 I=1,NJ
      XO(I)=XO(I)/XTO
  206 PRINT 801,XO(I)
      PRINT 401
  202 READ TAPE 6,(X(I),I=1,NV)
      IF END OF FILE 221,216
  216 Z=0.0
      DO 219 I=1,NV
  219 Z=Z+XO(I)*X(I)
      PRINT 801,Z
      GO TO 202
  221 PRINT 402
  220 READ TAPE 6,(X(I),I=1,NV)
      IF END OF FILE 230,226
  226 Z=0.0
      DO 229 I=1,NV
  229 Z=Z+XO(I)*X(I)
      PRINT 801,Z
      GO TO220
  230 TYPE,803
  803 FORMAT(8H THE END)
      STOP
  400 FORMAT(4B,E16.9)
  401 FORMAT(31H INDICES (Z VALUES) FOR GROUP 1)
  402 FORMAT(31H INDICES (Z VALUES) FOR GROUP 2)
  801 FORMAT(1B,7E17.9)
 4002 FORMAT(42H COEFFICIENTS OF THE DISCRIMINANT FUNCTION)
 4003 FORMAT(55H STANDARDIZED COEFFICIENTS OF THE DISCRIMINANT FUNCTION)
 1000 FORMAT(I2)
 2000 FORMAT(2F9.0)
 2001 FORMAT(2F9.0)
 3000 FORMAT(5E10.3)
 4000 FORMAT(17H  COUNT GROUP 1 =F9.1)
 4001 FORMAT(17H  COUNT GROUP 2 =F9.1)
      END
      END

      JOBEND
```

SAMPLE INPUT & OUTPUT

INPUT TEST DATA

```
02
6.36        5.24
5.92        5.12
5.92        5.36
6.44        5.64
6.40        5.16
6.56        5.56
6.64        5.36
6.68        4.96
6.72        5.48
6.76        5.60
6.72        5.08
 FINIS
6.00        4.88
5.60        4.64
5.64        4.96
5.76        4.80
5.96        5.08
5.72        5.04
5.64        4.96
5.44        4.88
5.04        4.44
4.56        4.04
5.48        4.20
5.76        4.80
 FINIS
 FINIS

CARDS  199
```

```
 COUNT GROUP 1 =      11.0
 COUNT GROUP 2 =      12.0
COEFFICIENTS OF THE DISCRIMINANT FUNCTION
  0.275932185E 00
  0.136711531E 00
STANDARDIZED COEFFICIENTS OF THE DISCRIMINANT FUNCTION
  0.100000000E 01
  0.495453369E 00
INDICES (Z VALUES) FOR GROUP 1
  0.895617565E 01
  0.845672125F 01
  0.857563006E 01
  0.923435700E 01
  0.895653939E 01
  0.931472073F 01
  0.929563006F 01
  0.913744871F 01
  0.943508446E 01
  0.953453887E 01
  0.923690312E 01
INDICES (Z VALUES) FOR GROUP 2
  0.841781244E 01
  0.789890363E 01
  0.809744871F 01
  0.813817617E 01
  0.847690312E 01
  0.821708498E 01
  0.809744871E 01
  0.785781244E 01
  0.723981296E 01
  0.656163161F 01
  0.756090415F 01
  0.813817617E 01
```

AXRS33

GENERAL ROUTINE AXRS33
MULTIPLE REGRESSION

T. A. Entzminger

PURPOSE: To find the least squares linear relationship

$(y_i - \bar{y}) = b_1 (x_{1_i} - \bar{x}_1) + b_2 (x_{2_i} - \bar{x}_2) + \ldots + b_n(x_{ni} - \bar{x}_n)$

of p dependent variables y_i, (i = 1, ... , p), on the independent variables x_j, (j = 1, ... , n).

RESTRICTIONS: 1) A maximum of 25 variables (independent plus dependent) can be treated in a run.

2) Input to computer is on cards.

ACCURACY: Single precisions floating point computations with eight significant digits.

OPTIONS: 1) Transformation of any variable can be made by inserting the proper Automath statements between the two transform comment cards in the source program deck (i.e., x(1) - LOGF x(1) or x(6) = SQRTF (x(6)) or x(13) = A+B*x(13) where A and B have been previously defined). (The program assumes that the first variables treated are independent and the last variables are dependent.)

INPUT:

Data may be punched punched on cards in any format which can be suitably described by an Automath Format statement. A considerable amount of running time can be saved by arranging the data so that they are treated by the READ statement in this manner (a)

INPUT (cont'd)

one observation of each variable in every read cycle (b) observations of all independent variables should proceed observations of dependent variables in the same read cycle. Standard card format is seven fields of 10 digits each; the last 10 digits may be used for identification.

CARD DECK SETUP:

1. Program Source Deck - complete with modified FORMAT statement (Statement #1001), transform statements, overlay card, Binary Subroutine Decks and Jobend card.
2. Name Card - Describes run uses card columns 2 - 80.
3. Control Card - Gives total number of variables (dependent plus independent) in card columns 1 and 2, and the number dependent variables only in card columns 3 and 4. To compute uncorrected (raw) sums of squares, enter a 1 in card column 5. If sums of squares are generated externally, enter a 1 in card column 6. For corrected sums of square and internally generated sums of squares, columns 5 and 6 must have a blank or zero entered.
4. Data - Card punched in most any form can be handled by this program (several variables per card or one per card) and is described by a FORMAT statement included in the program source deck.
5. FINIS CARD
6. Repeat steps 3 - 6 for each additional run.
7. FINIS CARD

*Note - When using additional transforms allow for reading them in format statement.

OUTPUT:

1. Computes and prints a matrix* of sums of squares (raw or corrected) and cross products.
2. Computes and prints a matrix* of simple correlation coefficients.
3. Computes and prints the following for each dependent variable:

   Degrees of freedom.

   Total sum of squares.

   Sum of squares for error.

   Mean square for error.

   Sum of squares for regression.

   Multiple correlation coefficient (R^2)

   Each regression coefficient.

   Standard error and Students T for each regression coefficient.

   Constant term in the regression.

   Analysis of variance Table.
4. Computes and prints the inverse matrix.
5. Computes and prints means and number of observations.

* - Only the upper triangular portion of the sums squares matrix and simple correlation coefficients matrix is printed.

DESCRIPTION & PROGRAM LISTING

```
      NEWSTACK
      COMPILES
      SUBROUTINE CORREL
      DIMENSION R(325),A1(325),X(25),AVG(25),AV(26)
      COMMON X,A1,NOELM,NCI,ND,AVG,AV,IRAW,AN,ISS,IDF
C     COMPUTATION OF CORRELATION MATRIX
      PRINT1222
      NC=NCI
      NCC=NC
      K=1
      NCA=0
      N1=1
      NE=1
      DO 456 L=1,NC
      DO 454 I=N1,NCC
      Z=A1(N1)*A1(K)
      IF(Z)7,2,2
    2 Z=SQRTF(A1(N1)*A1(K))
      R(I)=A1(I)/Z
    3 K=K+NCC-NCA
  454 NCA=NCA+1
      N1=NCC+1
      K=N1
    4 NCC=NCC+NC-NE
  456 NE=NE+1
      N1=1
      NN=NCI
      NE=1
      DO 6 K=1,NCI
      PRINT1998,K
      PRINT2000,(R(I),I=N1,NN)
      N1=NN+1
    5 NN=NN+NCI-NE
    6 NE=NE+1
      RETURN
    7 PRINT 3000,A1(N1),A1(K),L,I
      PRINT 2000,                    (A1(I),I=1,NOELM)
      STOP
 3000 FORMAT(2E16.9,2I2)
 1998 FORMAT(5H ROW I2)
 2000 FORMAT(1B,7E17.9//)
 1222 FORMAT(1H1/79H                                                  MATRIX OF SIMP
     1LE CORRELATION COEFFICIENTS////)
      END
      END
      JOBEND
      COMPILES
      SUBROUTINE DOOLIT
C     DETERMINATION OF REGRESSION COEFFICIENTS
      DIMENSION X(25),A1(325),B(325),RFGSS(10),XO(25),AVG(25),AV(26),
     1DIAG(25),D(25,25),C(25,25),S(10,25)
      DIMENSION TSS(10)
      COMMON X,A1,NOELM,NCI,ND,AVG,AV,IRAW,AN,ISS,IDF
      ERASE(REGSS)
      NC=NCI
```

```
      3 M=NC-ND+1
        MM=M
        NP=NC-ND
        NJ=NC-ND
        NG=NC-ND
        N1=1
        NN=NC+1
        NZ=2
        L2=1
        NT=NC
        NX=0
        DO 12J=N1,NG
    300 DO 5I=N1,NC
      5 B(I)=A1(I)/A1(N1)
C       DIAGONAL ELEMENTS
        DIAG(J)=A1(N1)
        NCX=NC -ND+1
        DO 36 KKR=1,ND
        REGSS(KKR)=A1(NCX)*B(NCX)+REGSS(KKR)
        S(ND,J)=A1(NCX)*B(NCX)
     36 NCX=NCX+1
        NNC=NC
        NN1=N1
        NNX=NX
        LL2=L2
      1 NN=NN-1
     10 L2=L2+1
        N1=NC+1
      2 NX=NX+1
        NC=NC+NT-NX
        K2=L2
        DO 8I=N1,NC
        A1(I)=A1(I)-A1(K2)*B(L2)
      8 K2=K2+1
        IF(NC-NOELM)10,11,11
     11 L2=LL2+NN
        NX=NNX+1
        N1=NNC+1
     12 NC=NNC+NT-NX
        DO 37 I=1,ND
     37 TSS(I)=X(I)
C       BACK SUBSTITUTION
C
        DO 31 I=1,NOELM
     31 A1(I)=B(I)
        II=0
C       START INVERSE COMPUTATIONS
        NC=NCI-ND
        ERASE(C)
        KK=0
        DO 391I=1,NC
        DO 39 J=I,NC
        KK=KK+1
        D(I,J)=A1(KK)
     39 D(J,I)=D(I,J)
```

```
  391 KK=KK+ND
      J=NC
      NN=1
      NO=0
      NM=NC-1
      NX=NC-1
      DO40I=1,NC
   40 C(I,I)=1.0/DIAG(I)
      DO41KK=1,NX
      K=NC-NO
      I=NC-NN
      DO42N=1,NM
      C(I,J)=C(I,J)-D(I,K)*C(K,J)
   42 I=I-1
      NN=NN+1
      NO=NO+1
   41 NM=NM-1
C     START GROUP 2
      NT=NC-3
      NK=1
      MT=NC-2
      N2=2
      DO54MA=1,MT
      NO=0
      J=J-1
      NN=N2
      K=NC-NO
      DO45KZ=1,NK
      C(J,J)=C(J,J)-D(J,K)*C(K,J)
   45 K=K-1
      NK=NK+1
      NM=NC-NT
      K=NC-NO
      I=NC-NN
      DO50NF=1,NK
      DO49N=1,NM
      C(I,J)=C(I,J)-D(I,K)*C(K,J)
   49 I=I-1
      K=K-1
      NC=NO+1
   50 I=NC-NN
      NN=NN+1
      NM=NM-1
      IF(NM)55,55,53
   53 NR=NX-NK
      DO52KK=1,NR
      K=NC-NO
      I=NC-NN
      DO51N=1,NM
      C(I,J)=C(I,J)-D(I,K)*C(K,J)
   51 I=I-1
      NN=NN+1
      NO=NO+1
   52 NM=NM-1
      NT=NT+1
```

```
   54 N2=N2+1
   55 K=2
      J=1
      DO60KZ=1,NK
      C(J,J)=C(J,J)-D(J,K)*C(K,J)
   60 K=K+1
      DO 63 I=1,NC
      DO 63 J=I,NC
   63 C(J,I)=C(I,J)
C     END COMPUTATION OF INVERSE
      DO 64 KK=1,ND
      IB=1
      IEN=NP
      IE=IEN
      K=0
   34 DO 35 I=IB,IE
    4 K=K+1
   35 B(K)=A1(I)
      III=I+II
      B(K+1)=A1(III)
    6 K=K+1
      IEN=IE-IB-1
      IB=IE+ND+1
      IE=IB+IEN
      IF(IEN)14,34,34
   14 N1=1
      M=MM
      NZ=1
      NC=NNC-NP*(ND-1)
      NC=NC
      DO 15I=N1,NJ
      X(I)=B(NO)
    7 NZ=NZ+1
   15 NO=NO-NZ
      NZ=2
      L=NJ-1
      NA=3
      DO 18J=1,L
      NO=NC-NA
      NC=NO
    9 N1=N1+1
      DO 16I=N1,NJ
      X(I)=X(I)-B(NO)*X(N1-1)
   13 NZ=NZ+1
   16 NC=NC-NZ
   17 NA=NA+1
   19 M=M-1
   18 NZ=NZ-M
      LK=NJ
      DO 20 I=1,NJ
      XC(I)=X(LK)
   20 LK=LK-1
   22 II=II+1
      DF=IDF
      NCT=NCT-ND+1
```

```
      NXX=NCT-ND
      CONST=AV(NCT)
      DO 62 I=1,NXX
   62 CONST=CONST-XO(I)*AV(I)
      RSQR=REGSS(KK)/TSS(KK)
      SSE=TSS(KK)-REGSS(KK)
      EMS=SSE/DF
      PRINT 1776,KK
 1776 FORMAT(1H1/50B,19HDEPENDENT VARIABLE I2)
      PRINT 1777,IDF,TSS(KK),SSE,EMS,REGSS(KK),RSQR
      PRINT 1888
      DO 65 J=1,NJ
      STDERR=SQRTF(EMS*C(J,J))
      T=XO(J)/STDERR
   65 PRINT1889,J,XO(J),STDERR,T
      PRINT 1788,CONST
      PRINT 1890
      DO 67J=1,NJ
   67 PRINT 1892,J,S(KK,J),S(KK,J)
   64 CONTINUE
 1777 FORMAT(1H /9B,2HDF5B,3HTSS14X,3HSSE14X,3HMSE14X,3HSSR12X,
     18HR SQUARE//6BI5,E15.8,4(2X,E15.8)///////)
 1788 FORMAT(1H /10B,11H CONSTANT =E17.9////)
 1888 FORMAT(1H /13B,1HB,17B,10HREGRESSION18B,
     114HSTANDARD ERROR18B,10HSTUDENTS T/
     230B,11HCOEFFICIENT///)
 1889 FORMAT(13B,I2,3(15B,E15.8)//)
      PRINT 1666
 1666 FORMAT(1H1/68H                                                    INVERSE
     1 MATRIX SOLUTION////)
      DO 66J=1,NXX
   66 PRINT 801,(C(I,J),I=1,NXX)
      RETURN
  800 FORMAT(I2,I3,I2)
  801 FORMAT(1B,7E17.9)
 1890 FORMAT(1H1/,47B,26HANALYSIS OF VARIANCE TABLE////5B,
     119HSOURCE OF VARIATION11B,18HDEGREES OF FREEDOM14B,
     215HSUMS OF SQUARES17B,11HMEAN SQUARE//)
 1892 FORMAT(8B,9HDUE TO  B,I2,24B,1H1,23B,E16.9,14B,E16.9//)
      END
      END
      JOBEND
```

```
      COMPILES
      SUBROUTINE SSCP
C     COMPUTES SUMS SQUARES,CROSSPRODUCTS,MEANS
      DIMENSION X(25),A1(325),AVG(25),AV(26),AVC(25)
      COMMON X,A1,NOELM,NCI,ND,AVG,AV,IRAW,AN,ISS,IDF
      NC=NCI
      NIND=NC-ND
      DO 5 I=1,NC
      AVG(I)=A1(I)/AN
      AV(I)=AVG(I)
      AVC(I)=AVG(I)
      IF(IRAW)55,5,55
   55 AVC(I)=0.0

    5 CONTINUE
      ERASE((A1(K),K=1,NOELM))
    8 READ TAPE 6,(X(I),I=1,NC)
      IF END OF FILE 42,6
    6 NN=1
      II=1
      K=1
      DO9I=II,NC
      TEMP=X(I)-AVC(I)
      DO 7 J=NN,NC
      A1(K)=TEMP*(X(J)-AVC(J))+A1(K)
    7 K=K+1
      NN=NN+1
    9 II=NN
      GO TO 8
   42 ASSIGN 23 TO I23
      NOELM=NC*(NC+1)/2
      REWIND6
      WRITE TAPE 6,(A1(I),I=1,NOELM)
   41 IF(ICC)43,44,43
   43 PRINT1005
      GO TO 45
   44 PRINT 1006
   45 N1=1
      NN=NCI
      NE=1
      DO46 K=1,NCI
      PRINT1999,K
 1999 FORMAT(14H           ROW I2)
   47 PRINT2000,(A1(I),I=N1,NN)
      N1=NN+1
      NN=NN+NCI-NE
   46 NE=NE+1
      GO TO I23,(23,22)
   23 ASSIGN 22 TO I23
   15 CALL CORREL
C     PULL SUM SQUARES DEVIATIONS FOR Y
   22 NY=ND
      NOY=NOELM
      N2=ND-1
      DO12I=1,ND
      X(NY)=A1(NOY)
      NY=NY-1
      NOY=NOY-(ND-NY)-1
```

```
  12 N2=N2-1
     NCELM=NIND*(NIND+1)/2+ND*NIND
     NNA=AN
     IDF=NNA-(NCI-ND+1)
     CALL DOOLIT
     PRINT 2010
2010 FORMAT(1H0///60H
    1      MEANS//)
     PRINT 2000,(AV (I),I=1,NC)
     PRINT2020
2020 FORMAT(1H0///69H

    1BER OF OBSERVATIONS//)
     PRINT3000,AN
3000 FORMAT(56B,F5.0)
     RETURN
1005 FORMAT(1H1/76H                                    UNCORRECTED SUMS OF SQ
    1UARES AND CROSS PRODUCTS////)
1006 FORMAT(1H1/76H                                      CORRECTED SUMS OF SQ
    1UARES AND CROSS PRODUCTS////)
2000 FORMAT(1B,7E17.9//)
     END
     END
     JCBEND
```

```
      COMPILEX
 TITLEAXRS33
C     T. A. ENTZMINGER
C     MULTIPLE REGRESSION
      COMMON X,A1,NOELM,NCI,ND,AVG,AV,IRAW,AN,ISS,IDF
      DIMENSION X(25),A1(325),AVG(25),AV(26),        TITLE(10)
      C=0.4342945
  100 REWIND 6
      READ 2003,TITLE
      IF END OF FILE 25,30
   30 PRINT2002,TITLE
      READ 1000,NCI,ND,IRAW,ISS
      NC=NCI
      NOELM=NC*(NC+1)/2
      ERASE((A1(K),K=1,NOELM))
      AN=0.0
    1 READ1001,(X(I),I=1,NC)
      IF END OF FILE 4,2
    2 IND3=IND3
C     INSERT TRANSFORMS AFTER STATEMENT 2
      X(1)=LOGF(X(1))*C
      X(2)=LOGF(X(2))*C
      X(3)=LOGF(X(3))*C
      X(4)=LOGF(X(4))*C
 1001 FORMAT(F4.0,F2.0,F4.0,F4.1)
C     END TRANSFORMS HERE
      DO 3 I=1,NC
    3 A1(I)=A1(I)+X(I)
      AN=AN+1.0
      WRITE TAPE 6,(X(I),I=1,NC)
      GO TO 1
    4 END FILE 6
      REWIND 6
      CALL SSCP
      GO TO 100
   25 TYPE,802
      STOP
  802 FORMAT(8HTHATS IT)
 1000 FORMAT(2I2,2I1)
 2002 FORMAT(1H1/20B,10A8)
 2003 FORMAT(10A8)
      END
      END

      OVERLAY
      STACKSSCP
      STACKCORREL
      STACKDOOLIT
      JOBEND
```

SAMPLE INPUT & OUTPUT

INPUT TEST DATA

MULTIPLE REGRESSION TEST

```
0401
0929023553 7.6
0929022713 4.4
0929021809 5.6
0929020904 3.7
0929063553 4.9
0929062713 4.2
0929061809 4.6
0929060904 3.3
0929243553 3.1
0929242713 2.2
0929241809 2.5
0929240904 1.7
1646022713 2.8
1646021809 2.7
1646020904 1.9
1646063553 2.2
1646062713 1.6
1646061809 1.7
1646060904 1.5
1646243553 1.1
1646242713 1.0
1646240908 0.3
2535023553 3.1
2535022713 1.7
2535021809 1.8
2535020908 1.7
2535063553 1.3
2535062713 1.3
2535061809 1.4
2535060908 1.2
2535243553  .7
2535242713  .5
2535241809  .5
2535240908  .3
3869023553  .4
3869022713  .6
3869021809  .5
3869020908  .3
3869063553  .2
3869062713  .2
3869061809  .4
3869060908 .03
3869243553  .3
3869242713  .2

3869241809  .2
3869240904  .1
 FINIS
```

CARDS 445

MULTIPLE REGRESSION TEST

UNCORRECTED SUMS OF SQUARES AND CROSS PRODUCTS

```
        ROW  1
 0.2514379965 01  0.337120500E-02  0.195059981E-01 -0.455995363E 01
        ROW  2
 0.8775462875 01  0.153649437E 00 -0.377022927E 01
        ROW  3
 0.233406509E 01  0.105252209E 01
        ROW  4
 0.123917686E 02
```

MATRIX OF SIMPLE CORRELATION COEFFICIENTS

```
ROW  1
  0.100000000E 01  0.71768636DE-03  0.7639071D6E-02 -0.816917736E 00
ROW  2
  0.100000000E 01  0.339499321E-01 -0.362411170E 00
ROW  3
  0.100000000E 01  0.195707779E 00
ROW  4
  0.100000000E 01
```

DEPENDENT VARIABLE 1

DF	TSS	SSE	MSE	SSR	R SQUARE
42	0.12391769E 02	0.19303635E 01	0.45961037E-01	0.10461405E 02	0.84422211E 00

B	REGRESSION COEFFICIENT	STANDARD ERROR	STUDENTS T
1	-0.18145993E 01	0.13520086E 00	-0.13436300E 02
2	-0.43841402E 00	0.72370238E-01	-0.60606961E 01
3	0.49421620E 00	0.14041111E 00	0.35197800E 01

CONSTANT = 0.4745129 32E 01

ANALYSIS OF VARIANCE TABLE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARE
DUE TO B 1	1	0.826970362E 01	0.826970362E 01
DUE TO B 2	1	0.162229702E 01	0.162229702E 01
DUE TO B 3	1	0.569404441E 00	0.569404441E 00

INVERSE MATRIX SOLUTION

0.397712365E 00	-0.152786311E-03	-0.314707799E-02
-0.152786311E-03	0.113954162E 00	-0.750937107E-02
-0.314707799E-02	-0.750937107E-02	0.428056384E 00

MEANS

0.329737853E 01	0.818892172E 00	0.329511522E 01	0.244354565E-01

NUMBER OF OBSERVATIONS

AXRS38

GENERAL ROUTINE AXRS38
LEAST SQUARES CURVE FIT

PURPOSE: This program generates an approximating polynomial by the least squares technique. The equation so derived contains as many terms as necessary to bring the standard error of the dependent variable within a range specified by the user.

RESTRICTIONS: Provision has been made for a maximum of 400 observations (can be enlarged) and a polynomial expansion up to the 15th degree. This program is based on the assumption that a set of experimental data can be fitted to a polynomial of the form:

$Y = A_0 + A_1 x + A_2 x^2 + A_3 x^3 \text{ ---------- } + A_{15} x^{15}$

PURPOSE: The linear form $Y = A_0 + A_1 X$ is tried as a first approximation. The coefficients are computed and the standard error of the dependent variable (Y) is compared to a predetermined tolerance. If the error is greater than this maximum value the process is repeated, adding a term of the form $A_n x^n$ (where n = 2, 3 ...., 15) until the error is within the tolerance.

ACCURACY: Single precision floating point computations with eight significant digits.

INPUT: The input to the program consists of two types of records. The first is a control which contains N, the number of pairs, the tolerance and the highest degree of fit. The next N records are the observations of X, Y, and the weighing factor W.

CARD DECK SETUP:

1. Control card

	Card columns
Number of pairs	8-10
*Tolerance	20-30*
Highest degree of fit	39-40

*Decimal point must be punched on card

2. Data cards

May have any format - programmer must change Format statements #2000 and #3000 accordingly. Standard format as follows:

	Card columns
X value	1-10*
Y value	11-20*
Weighing factor	21-30*

*Decimal points must be shown unless values are integers.

OUTPUT: Program prints tolerance, standard deviation, number of pairs fitted, least squares coefficients, X values, Y values, predicted Y values, and the difference between observed and predicted Y values for each order of the polynomial.

DESCRIPTION & PROGRAM LISTING

```
      COMPILEX
 TITLEAXRS38
C     LEAST SQUARES CURVE FIT
C     T.A.FNTZMINGER
      DIMENSIONX(400),Y(400),A(16,16),SUMX(31),SUMY(15),W(400)
    1 READ1000,N,TOL,LAST
      IF END OF FILE 174,18
   18 IF(SENSESWITCH1)30,20
   20 READ 2000,(X(I),Y(I),I=1,N)
      GO TO 40
   30 READ 3000,(X(I),Y(I),W(I),I=1,N)
   40 IF(SENSESWITCH1)70,50
   50 DO60I=1,N
   60 W(I)=1.
   70 SUMX(1)=0.
      SS2=0.0
      SUMX(2)=0.
      SUMX(3)=0.
      SUMY(1)=0.
      SUMY(2)=0.
      DO90I=1,N
      SUMX(1)=SUMX(1)+W(I)
      SUMX(2)=SUMX(2)+W(I)*X(I)
      SUMX(3)=SUMX(3)+W(I)*X(I)*X(I)
      SUMY(1)=SUMY(1)+W(I)*Y(I)
      SS2=SS2+Y(I)*Y(I)*W(I)
   90 SUMY(2)=SUMY(2)+W(I)*X(I)*Y(I)
      SS2=SS2-SUMY(1)*SUMY(1)/SUMX(1)
      NORD=1
   91 L=NORD+1
      KK=L+1
      DO101I=1,L
      DO100J=1,L
      IK=J-1+I
  100 A(I,J)=SUMX(IK)
  101 A(I,KK)=SUMY(I)
      DO140I=1,L
      A(KK,I)=-1.
      KKK=I+1
      DO110J=KKK,KK
  110 A(KK,J)=0.
      C=1./A(1,1)
      DO120II=2,KK
      DO120J=KKK,KK
  120 A(II,J)=A(II,J)-A(1,J)*A(II,I)*C
      DO140II=1,L
      DO140J=KKK,KK
  140 A(II,J)=A(II+1,J)
      S2=0.
      DO160J=1,N
      S1=0.
      S1=S1+A(1,KK)
      DO150I=1,NORD
  150 S1=S1+A(I+1,KK)*X(J)**I
  160 S2=S2+(S1-Y(J))*(S1-Y(J))
```

```
      B=N-L
      FTEST=(SS2-S2)*B/S2
      SS2=S2
      S2=(S2/B)**.5
  163 PRINT3
      PRINT4,NORD,TOL,S2,N
      PRINT1010,FTEST
 1010 FORMAT(1H0/45B,10HF VALUE = F16.9//)
      PRINT10
      DO1641=1,L
      J=I-1
  164 PRINT 5,J,A(I,KK)
  167 PRINT 11
      DO 169 I=1,N
      S1=0.
      S1=A(1,KK)
      DO168J=1,NORD
  168 S1=S1+A(J+1,KK)*X(I)**J
      S3=Y(I)-S1
  169 PRINT 6,X(I),Y(I),S1,S3
      IF(NORD-LAST)170,173,173
  170 IF(S2-TOL)173,173,171
  171 NORD=NORD+1
      J=2*NORD
      SUMX(J)=0.
      SUMX(J+1)=0.
      SUMY(NORD+1)=0.
      DO172I=1,N
      SUMX(J)=SUMX(J)+X(I)**(J-1)*W(I)
      SUMX(J+1)=SUMX(J+1)+X(I)**J*W(I)
  172 SUMY(NORD+1)=SUMY(NORD+1)+Y(I)*X(I)**NORD*W(I)
      GOTO91
  173 GO TO 1
  174 TYPE,175
  175 FORMAT(8H THE END)
      STOP
 1000 FORMAT(7B,I3,10B,F10.0,8B,I2)
 2000 FORMAT(2F10.0)
 3000 FORMAT(15B,F3.0,F10.4,F10.4)
    3 FORMAT(1H1/70H                                                    LEAST
     1 SQUARES CURVE FIT///)
    4 FORMAT(93H                              ORDER          TOLERANCE
     1          SIGMA                          N//27B,I2,8B,E16.9,9B,E16.9,
     215B,I3/////)
   10 FORMAT(67H                                                        C
     1OEFFICIENTS//)
    5 FORMAT(45B,I2,7B,E16.9)
   11 FORMAT(95H2                                 X(I)                 Y(I)
     1            F(X)              Y-F(X))//)
    6 FORMAT(17B,4E21.9)
      END
      END
      JOBEND
```

SAMPLE INPUT & OUTPUT

INPUT TEST DATA

	016	.001		04
0.5	0.67	0.52	0.52	
1.0	0.87	0.57	0.56	
1.5	1.04	0.59	0.59	
2.0	1.21	0.61	0.61	
2.5	1.38	0.63	0.63	
3.0	1.55	0.65	0.65	
3.5	1.72	0.67	0.66	
4.0	1.86	0.66	0.66	
4.5	2.00	0.65	0.66	
5.0	2.14	0.64	0.65	
5.5	2.28	0.63	0.64	
6.0	2.42	0.62	0.62	
6.5	2.56	0.61	0.60	
7.0	2.67	0.57	0.58	
7.5	2.81	0.56	0.55	
8.0	2.92	0.52	0.52	

FINIS
CARDS 130

LEAST SQUARES CURVE FIT

ORDER	TOLERANCE	SIGMA	N
1	0.100000000E-02	0.484711646E-01	16

F VALUE = 0.321661260E 04

COEFFICIENTS

0	0.614000001E 00
1	0.298176471E 00

X(I)	Y(I)	F(X)	Y-F(X))
0.500000000E 00	0.670000000E 00	0.763088236E 00	-0.930882362E-01
0.100000000E 01	0.870000000E 00	0.912176472E 00	-0.421764715E-01
0.150000000E 01	0.104000000E 01	0.106126471E 01	-0.212647060E-01
0.200000000E 01	0.121000000E 01	0.121035294E 01	-0.352942000E-03
0.250000000E 01	0.138000000E 01	0.135944118E 01	0.205588230E-01
0.300000000E 01	0.155000000E 01	0.150852941E 01	0.414705880E-01
0.350000000E 01	0.172000000E 01	0.165761765E 01	0.623823530E-01
0.400000000E 01	0.186000000E 01	0.180670588E 01	0.532941170E-01
0.450000000E 01	0.200000000E 01	0.195579412E 01	0.442058820E-01
0.500000000E 01	0.214000000E 01	0.210488235E 01	0.351176470E-01
0.550000000E 01	0.228000000E 01	0.225397059E 01	0.260294120E-01
0.600000000E 01	0.242000000E 01	0.240305882E 01	0.169411760E-01
0.650000000E 01	0.256000000E 01	0.255214706E 01	0.785294100E-02
0.700000000E 01	0.267000000E 01	0.270123529E 01	-0.312352940E-01
0.750000000E 01	0.281000000E 01	0.285032353E 01	-0.403235290E-01
0.800000000E 01	0.292000000E 01	0.299941177E 01	-0.794117650E-01

LEAST SQUARES CURVE FIT

ORDER	TOLERANCE	SIGMA	N
2	0.100000000E-02	0.870826460E-02	16

F VALUE = 0.420742233E 03

COEFFICIENTS

0	0.493464291E 00
1	0.378533610E 00
2	-0.945378118E-02

X(I)	Y(I)	F(X)	Y-F(X)
0.500000000E 00	0.670000000E 00	0.680367651E 00	-0.103676511E-01
0.100000000E 01	0.870000000E 00	0.862544120E 00	0.745587960E-02
0.150000000E 01	0.104000000E 01	0.103999370E 01	0.630100000E-05
0.200000000E 01	0.121000000E 01	0.121271639E 01	-0.271638700E-02
0.250000000E 01	0.138000000E 01	0.138071219E 01	-0.712185000E-03
0.300000000E 01	0.155000000E 01	0.154398109E 01	0.601890800E-02
0.350000000E 01	0.172000000E 01	0.170252311E 01	0.174768920E-01
0.400000000E 01	0.186000000E 01	0.185633823E 01	0.366176600E-02
0.450000000E 01	0.200000000E 01	0.200542647E 01	-0.542646900E-02
0.500000000E 01	0.214000000E 01	0.214978781E 01	-0.978781400E-02
0.550000000E 01	0.228000000E 01	0.228942227E 01	-0.942226800E-02
0.600000000E 01	0.242000000E 01	0.242432983E 01	-0.432983100E-02
0.650000000E 01	0.256000000E 01	0.255451050E 01	0.548949600E-02
0.700000000E 01	0.267000000E 01	0.267996429E 01	-0.996428600E-02
0.750000000E 01	0.281000000E 01	0.280069118E 01	0.930882200E-02
0.800000000E 01	0.292000000E 01	0.291669118E 01	0.330882100E-02

LEAST SQUARES CURVE FIT

ORDER	TOLERANCE	SIGMA	N
3	0.100000000E-02	0.776470968E-02	16

F VALUE = 0.435144521E 01

COEFFICIENTS

0	0.477829689E 00
1	0.397755512E 00
2	-0.149396066E-01
3	0.430260818E-03

X(I)	Y(I)	F(X)	Y-F(X))
0.500000000E 00	0.670000000E 00	0.673026326E 00	-0.302632610E-02
0.100000000E 01	0.870000000E 00	0.861075856E 00	0.892414450E-02
0.150000000E 01	0.104000000E 01	0.104230097E 01	-0.230097300E-02
0.200000000E 01	0.121000000E 01	0.121702437E 01	-0.702437300E-02
0.250000000E 01	0.138000000E 01	0.138556875E 01	-0.556875300E-02
0.300000000E 01	0.155000000E 01	0.154825681E 01	0.174319200E-02
0.350000000E 01	0.172000000E 01	0.170541123E 01	0.145887670E-01
0.400000000E 01	0.186000000E 01	0.185735472E 01	0.264527600E-02
0.450000000E 01	0.200000000E 01	0.200440998E 01	-0.440997700E-02
0.500000000E 01	0.214000000E 01	0.214689969E 01	-0.689968800E-02
0.550000000E 01	0.228000000E 01	0.228514655E 01	-0.514655000E-02
0.600000000E 01	0.242000000E 01	0.241947326E 01	0.526738000E-03
0.650000000E 01	0.256000000E 01	0.255020252E 01	0.979748300E-02
0.700000000E 01	0.267000000E 01	0.267765701E 01	-0.765701200E-02
0.750000000E 01	0.281000000E 01	0.280215944E 01	0.784055800E-02
0.800000000E 01	0.292000000E 01	0.292403250E 01	-0.403250300E-02

LEAST SQUARES CURVE FIT

ORDER	TOLERANCE	SIGMA	N
4	0.100000000E-02	0.810379424E-02	16

F VALUE = 0.167851096E-01

COEFFICIENTS

0	0.476346231E 00
1	0.400505548E 00
2	-0.162954878E-01
3	0.673166142E-03
4	-0.142885480E-04

X(I)	Y(I)	F(X)	Y-F(X))
0.500000000E 00	0.670000000E 00	0.672608386E 00	-0.260838600E-02
0.100000000E 01	0.870000000E 00	0.861215169E 00	0.878483120E-02
0.150000000E 01	0.104000000E 01	0.104263931E 01	-0.263930500E-02
0.200000000E 01	0.121000000E 01	0.121733209E 01	-0.733208800E-02
0.250000000E 01	0.138000000E 01	0.138572338E 01	-0.572337600E-02
0.300000000E 01	0.155000000E 01	0.154822160E 01	0.177840400E-02
0.350000000E 01	0.172000000E 01	0.170521375E 01	0.147862550E-01
0.400000000E 01	0.186000000E 01	0.185706538E 01	0.293461800E-02
0.450000000E 01	0.200000000E 01	0.200412063E 01	-0.412063400E-02
0.500000000E 01	0.214000000E 01	0.214670220E 01	-0.670219900E-02
0.550000000E 01	0.228000000E 01	0.228511134E 01	-0.511133800E-02
0.600000000E 01	0.242000000E 01	0.241962788E 01	0.372117000E-03
0.650000000E 01	0.256000000E 01	0.255051023E 01	0.948976900E-02
0.700000000E 01	0.267000000E 01	0.267799535E 01	-0.799534500E-02
0.750000000E 01	0.281000000E 01	0.280229876E 01	0.770124400E-02
0.800000000E 01	0.292000000E 01	0.292361456E 01	-0.361456400E-02

AXRS43

GENERAL ROUTINE AXRS43
GENERAL CORRELATION PROGRAM

T. A. Entzminger

PURPOSE: This program computes simple correlation, partial correlation and partial regression coefficients of a matrix.

RESTRICTIONS: 1) A maximum of 24 variables can be treated in each run.

2) Input to the computer is on cards.

ACCURACY: Single precision floating point - with eight significant digits.

OPTIONS: Transformations may be made on any of the input variables by inserting the proper automath statements in the appropriate place in the source program deck.

INPUT: Data may be punched on cards in any format which can be suitably described by the automath FORMAT statement.

CARD DECK SETUP:

1. Program source deck
2. Name card
3. Control card

	Card Column
No. of variables	1-2
Calculation route	3

one if simple correlation coefficients are required only.

Blank or zero for simple correlation, partial correlation and partial regression coefficients.

4. Data cards
5. Finis card

OUTPUT: 1) Matrix (*) of sums of squares deviations and cross products

2) Matrix (*) of simple correlation coefficients

3) Elements of the inverse of the simple correlation matrix

4) Matrix (*) of partial correlation coefficients

5) Matrix (**) of partial regression coefficients

6) Mean value of each variable

7) Total number of observations

* - only the upper triangular portion of this matrix is printed

** - printout for partial regression coefficients in this form:

$r_{11.234---n}$, $r_{11.234---n}$, $r_{12.34---n}$, $r_{21.34---n}$. $r_{13.24---n}$, etc

Reference - "Methods of Statistical Analysis",
Cyril H. Goulden - 2nd Edition
John Wiley & Sons
New York 1952

DESCRIPTION & PROGRAM LISTING

```
      NEWSTACK
      COMPILES
      SUBROUTINE CORREL
      DIMENSIONX(24),A1(876),B(600),R(876)
      COMMON X,A1,NOELM,NCI,ND,IND3
C     COMPUTATION OF CORRELATION MATRIX
      ERASE((R(I),I=1,NOELM))
      IF(IND3)2,1,2
    1 PRINT 1221
      GO TO 3
    2 PRINT 1222
    3 NC=NCI
      NCO=NC
      JJ=0
      K=1
      NCA=0
      N1=1
      NE=1
      J=0
      N=1
      DO456L=1,NC
      DO454I=N1,NCO
      J=J+1
      R(J)=A1(I)/SQRTF(A1(N1)*A1(K))
      IF(IND3)19,20,19
   19 R(J)=0.0-R(J)
      B(N)=(A1(I)/A1(N1))*(-1.0)
      B(N+1)=(A1(I)/A1(K))*(-1.0)
      N=N+2
   20 K=K+NCO-NCA
  454 NCA=NCA+1
      IF(IND3)460,459,460
  459 M=J+NC
      J=J+1
      DO455MM=J,M
  455 R(MM)=0.0
      MMM=J+JJ
      R(MMM)=1.0
      JJ=JJ+1
      J=M
  460 N1=NCO+1
      K=N1
      NCO=NCO+NC-NE
  456 NE=NE+1
      N1=1
      NN=NCI
      NE=1
      DO 6 K=1,NCI
      PRINT1998,K
      PRINT2000,(R(I),I=N1,NN)
      IF(IND3)10,8,10
    8 N1=NN+1+NCI
      NN=NN+NCI-NE+NCI
      GO TO 6
   10 N1=NN+1
```

```
      NN=NN+NCI-NE
    6 NE=NE+1
      IF (IND3)29,30,29
   29 N1=NOELM*2
      PRINT 1223
      PRINT2000,(B(I),I=1,N1)
      GO TO 31
   30 DO7I=1,NOELM
    7 A1(I)=R(I)
   31 RETURN
 1998 FORMAT(5H ROW I2)
 2000 FORMAT(1B,7E17.9//)
 1221 FORMAT(1H1/79H                                          MATRIX OF SIMP
     1LE CORRELATION COEFFICIENTS////)
 1222 FORMAT(1H1/79H                                          MATRIX OF PARTI
     1AL CORRELATION COEFFICIENTS////)
 1223 FORMAT(1H1/79H                                          MATRIX OF PART
     1IAL REGRESSION COEFFICIENTS////)
      END
      END
      JOBEND
```

```
      COMPILES
      SUBROUTINEINVERT
C     MATRIX INVERSION BY THE DOOLITTLE METHOD
      DIMENSIONX(24),A1(876),B(876),XO(24)
      COMMON X,A1,NOELM,NCI,ND,IND3
      PRINT1333
      REWIND6
      ND=NCI
      NC=NCI*2
      M=NC-ND-1
      MM=M
      NP=NC-ND
      NJ=NC-ND
      NQ=NC-ND
      N1=1
      NN=NC+1
      NZ=2
      L2=1
      NT=NC
      NX=0
      DO 12J=N1,NQ
  300 DO 5I=N1,NC
    5 B(I)=A1(I)/A1(N1)
  400 PRINT 801,(A1(I),I=N1,NC)
      PRINT 801,(B (I),I=N1,NC)
      NNC=NC
      NN1=N1
      NNX=NX
      LL2=L2
      NN=NN-1
   10 L2=L2+1
      N1=NC+1
      NX=NX+1
      NC=NC+NT-NX

      K2=L2
      DO 8I=N1,NC
      A1(I)=A1(I)-A1(K2)*B(L2)
    8 K2=K2+1
      IF(NC-NOELM)10,11,11
   11 L2=LL2+NN
      NX=NNX+1
      N1=NNC+1
   12 NC=NNC+NT-NX
C
C     BACK SUBSTITUTION
C
      PRINT1444
      DO 31 I=1,NOELM
   31 A1(I)=B(I)
      II=0
      DO 22 KK=1,ND
      IB=1
      IEN=NP
      IE=IEN
      K=0
```

```
   34 DO 35 I=IB,IE
      K=K+1
   35 B(K)=A1(I)
      III=I+II
      B(K+1)=A1(III)
      K=K+1
      IEN=IE-IB-1
      IB=IE+ND+1
      IE=IB+IEN
      IF(IEN)14,34,34
   14 N1=1
      M=MM
      NZ=1
      NC=NNC-NP*(ND-1)
      NO=NC
      DO 15I=N1,NJ
      X(I)=B(NO)
      NZ=NZ+1
   15 NO=NO-NZ
      NZ=2
      L=NJ-1
      NA=3
      DO 18J=1,L
      NC=NC-NA
      NC=NO
      N1=N1+1
      DO 16I=N1,NJ
      X(I)=X(I)-B(NO)*X(N1-1)
      NZ=NZ+1
   16 NC=NO-NZ
      NA=NA+1
      M=M-1
   18 NZ=NZ-M
      LK=NJ

      DO 20 I=1,NJ
      XO(I)=X(LK)
   20 LK=LK-1
C     PRINT+WRITE C PRIME MATRIX ON WORK TAPE
      PRINT 1443,KK
 1443 FORMAT(1H /6H ROW  I2)
      PRINT 801,(XO(I),I=1,NJ)
      WRITE TAPE6,(XO(I),I=1,NJ)
   22 II=II+1
      REWIND6
      NOELM=NCI*(NCI+1)/2
      K=0
      N1=1
      DO 23 J=1,NJ
      READ TAPE 6,(XO(I),I=1,NJ)
      DO 24 KK=N1,NJ
      K=K+1
   24 A1(K)=XO(KK)
```

```
   23 N1=N1+1
      RETURN
  800 FORMAT(I2,I3,I2)
  801 FORMAT(1P,7E17.9)
 1333 FORMAT(1H1/70H                                                    TRIA
     1NGULARIZED MATRIX ////)
 1444 FORMAT(1H1/70H                                                    INVER
     1SE ELEMENTS       ////)
      END
      END
      JOBEND
```

```
      COMPILEX
 TITLEAXRS43
C      CORRECTED SUMS OF SQUARES AND CROSS PRODUCTS
C      PARTIAL+MULTIPLE REGRESSION+CORRELATION
       DIMENSIONX(24),A1(876),AVG(24)
       COMMON X,A1,NOELM,NCI,ND,IND3
C      IF KIND IS BLANK-PROGRAM
C      FOLLOWS NORMAL PATH-(COMPLETE PARTIALS)
C      IF KIND =1 PROGRAM COMPUTES
C      SS DEVIATIONS, MEANS AND SIMPLE
C      CORRELATION COEFFICIENTS ONLY.
  100  REWIND 6
       READ1000,NCI,KIND
       IF END OF FILE 25,30
   30  NC=NCI
       NOELM=NC*(NC+1)/2
       ERASE((A1(K),K=1,NOELM))
       AN=0.0
    1  READ1001,(X(I),I=1,NC)
       IF END OF FILE 4,2
    2  NC=NC
C      INSERT TRANSFORMS HERE
 1001  FORMAT(4F2.1)
C      END OF TRANSFORMS
       DO 3 I=1,NC
    3  A1(I)=A1(I)+X(I)

       AN=AN+1.0
       WRITE TAPE 6,(X(I),I=1,NC)
       GO TO 1
    4  END FILE 6
       REWIND 6
       DO 5 I=1,NC
    5  AVG(I)=A1(I)/AN
       ERASE((A1(K),K=1,NOELM))
    8  READ TAPE 6,(X(I),I=1,NC)
       IF END OF FILE41,6
    6  NN=1
       II=1
       K=1
       DC9I=II,NC
       TEMP=X(I)-AVG(I)
       DC 7 J=NN,NC
       A1(K)=TEMP*(X(J)-AVG(J))+A1(K)
    7  K=K+1
       NN=NN+1
    9  II=NN
       GC TO 8
   41  PRINT1111
 1111  FORMAT(1H1/82H                                                  SUM OF SQUARES OF
      1 DEVIATIONS AND CROSS PRODUCTS////)
```

```
   45 N1=1
      NN=NCI
      NE=1
      DO46 K=1,NCI
      PRINT1999,K
 1999 FORMAT(14H            ROW I2)
   47 PRINT2000,(A1(I),I=N1,NN)
      N1=NN+1
      NN=NN+NCI-NE
   46 NE=NE+1
   15 IND3=0
      NOELM=NOELM+NC*NC
      CALL CORREL
      IF(KIND)2003,2003,2005
 2003 CALL INVERT
      IND3=1
      CALL CORREL
 2005 PRINT 2010
 2010 FORMAT(1H0///60H
     1      MEANS//)
      PRINT 2000,(AVG(I),I=1,NC)
      PRINT2020
 2020 FORMAT(1H0///69H                                                  NUM
     1BER OF OBSERVATIONS//)
      PRINT3000,AN
 3000 FORMAT(56B,F5.0)
      GO TO 100
   25 TYPE,802
      STOP
 1000 FORMAT(I2,I1)
 2000 FORMAT(1B,7E17.9//)

  802 FORMAT(8HTHATS IT)
      END
      END
      OVERLAY
      STACKCORREL
      STACKINVERT
      JCBEND
```

SAMPLE INPUT & OUTPUT

INPUT TEST DATA

```
04
20711187
43721286
35731385
24841491
50651592
34761193
39871287
36681391
25691488
27711592
40721188
46731293
 FINIS
 FINIS


CARDS  303
```

SUM OF SQUARES OF DEVIATIONS AND CROSS PRODUCTS

ROW 1
0.9524166666E 01 -0.1195833334E 01 -0.8250000000E-01 0.4441666667E 00
ROW 2
0.4388166666E 01 -0.2475000000E 00 -0.2408333333E 00
ROW 3
0.2425000000E 00 0.1325000003E 00
ROW 4
0.9091666666E 00

MATRIX OF SIMPLE CORRELATION COEFFICIENTS

ROW 1
0.10000000000E 01 -0.1839438448E 00 -0.5398880938E-01 0.1501169948E 00
ROW 2
0.1000000000E 01 -0.2398989224E 00 -0.1205601588E 00
ROW 3
0.1000000000E 01 0.2821879148E 00
ROW 4
0.1000000000E 01

TRIANGULARIZED MATRIX

0.100000000E 01	-0.183943848E 00	-0.539888803E-01	0.150116994E 00	0.100000000E 01	0.000000000E 00	0.000000000E 00
0.000000000E 00						
0.100000000E 01	-0.183943848E 00	-0.539888803E-01	0.150116994E 00	0.100000000E 01	0.000000000E 00	0.000000000E 00
0.000000000E 00						
0.966164661E 00	-0.249829830E 00	-0.929470607E-01	0.183943848E 00	0.100000000E 01	0.000000000E 00	0.000000000E 00
0.100000000E 01	-0.258578936E 00	-0.962020911E-01	0.190385609E 00	0.103502026E 01	0.000000000E 00	0.000000000E 00
0.932484477E 00	0.266258299E 00	0.101552811E 00	0.258578936E 00	0.100000000E 01	0.000000000E 00	
0.100000000E 01	0.285536441E 00	0.108905641E 00	0.277301063E 00	0.107240391E 01	0.000000000E 00	
0.892496741E 00	-0.161418239E 00	0.223683819E-01	-0.285536441E 00	0.100000000E 01		
0.100000000E 01	-0.180861435E 00	0.250627043E-01	-0.319929954E 00	0.112045227E 01		

INVERSE ELEMENTS

ROW 1
0.1075274275 01 0.2145007345 00 0.1609481615 00 -0.1808614335 00

ROW 2
0.2145007345 00 0.1107285095 01 0.2701447475 00 0.2506270435-01

ROW 3
0.1609481615 00 0.2701447475 00 0.1163755575 01 -0.3199299545 00

ROW 4
-0.1808614335 00 0.2506270445-01 -0.3199299 45 00 0.1120452275 01

MATRIX OF PARTIAL CORRELATION COEFFICIENTS

ROW 1
-0.1[illegible]E 01 -0.196580146E 00 -0.143520782E 00 0.154774370E 00
ROW 2
-0.1[illegible]E 01 -0.237977512E 00 -0.225009847E-01
ROW 3
-0.1[illegible]E 01 0.280173581E 00
ROW 4
-0.1[illegible]E 01

MATRIX OF PARTIAL REGRESSION COEFFICIENTS

-0.100000000E 01 -0.100000000E 01 -0.199484672E 00 -0.193717713E 00 -0.149309033E 00 -0.137956943E 00 0.168200280E 00

0.161418239E 00 -0.100000000E 01 -0.100000000E 01 -0.243970366E 00 -0.232131862E 00 -0.226343736E-01 -0.223683819E-01

-0.100000000E 01 -0.100000000E 01 0.274911641E 00 0.285536441E 00 -0.100000000E 01 -0.100000000E 01

MEANS

0.349166667E 01 0.734166667E 01 0.127500000E 01 0.894166667E 01

NUMBER OF OBSERVATIONS

12.

AXRS49

AXRS49 MULTIVARIATE ANALYSIS OF VARIANCE

PURPOSE: Generalizes the univariate analysis of variance F test to the problem of testing the significance of differences among groups. Major computations are of H_1 - the null hypothesis of the equality of g group dispersion matrices, H_2 - WILKS' lambda and F_1 and F_2 the related significance tests.

LIMITATIONS: Ten groups consisting of not more than ten variables. Input on cards.

ACCURACY: Single precision floating point computations truncated to eight significant digits.

INPUT:

1.	Control card #1	cc
	Number of groups	1 - 2
	Number of variables per group	3 - 4
2.	Control card #2	cc
	Number of variables per group	1 - 2
	Number of observations per variable	3 - 7
3.	Data cards (observations) in group #1	
4.	Repeat steps 2 and 3 above for each additional group to be analyzed.	
5.	FINIS CARD	

OUTPUT: Printed output includes:

1. Program title and number of groups.
2. Group means, standard deviation and the dispersion matrix for each group.
3. Log base e of determinant of each group dispersion matrix and corresponding determinant.
4. Log base e of determinant of pooled within groups estimate W and corresponding determinant.
5. Mean, standard deviation, dispersion matrix, and correlation matrix for total sample.
6. Log base e of determinant of SS matrix and corresponding determinant.
7. Wilks' lambda and corresponding F values.

REFERENCE: This program, which was extracted from a text book by Cooley and Lohnes (Multivariate Procedures for the Behavioral Sciences, Wiley 1962) has been modified for use on the Honeywell 400 computer. A complete discussion, output symbols and mathematical procedures can be found in the text.

DESCRIPTION & PROGRAM LISTING

```
      NEWSTACK
      COMPILES
      SUBROUTINE CORR
      DIMENSIONSX(10),SSD(10,10),SS(10,10),D(10,10),R(10,10),
     1XM(10),SD(10),H(10,10),U(10,10)
      DIMENSIONTITLE(12),X(10),JX(10)
      COMMONSX,SSD,SS,D,R,XM,SD,H,U,M,NG,TITLE
      ENG=NG
  370 IF(L8)405,405,375
  375 PRINT376
  376 FORMAT(39H RAW SUMS OF SQUARES AND CROSS PRODUCTS)
      INK=1
      GO TO 4
  405 PRINT406
  406 FORMAT(45H DEVIATION SUMS OF SQUARES AND CROSS PRODUCTS)
      INK=2
      GO TO 4
  430 IF(L1)700,700,435
  435 DO441I=1,M
      DO441J=I,M
      D(I,J)=SSD(I,J)/(ENG-1.0)
  441 D(J,I)=D(I,J)
C     DISPERSION MATRIX
  450 PRINT451
  451 FORMAT(27H VARIANCE-COVARIANCE MATRIX)
      INK=3
      GO TO 4
  475 DO486 I=1,M
      DO486J=I,M
      R(I,J)=D(I,J)/(SD(I)*SD(J))
  486 R(J,I)=R(I,J)
C     CORRELATION MATRIX
  628 PRINT50,(TITLE(I),I=1,12),NG
   50 FORMAT(21H CORRELATION MATRIX ,12A6,1B,2HN=,I4)
      INK=4
      GO TO 4
   61 PRINT 62,(XM(J),J=1,M)
   62 FORMAT(6H MEANS,4B,10F11.2/(10B,10F11.2))
      PRINT 63,(SD(J),J=1,M)
   63 FORMAT(8H STD DEV,2B,10F11.2/(10B,10F11.2))
  700 RETURN
    4 L1=9
    5 J1=0
      J2=0
      JSEC=0
      DO8I=1,M
    8 JX(I)=I
    9 J1=J2+1
      J2=J1+L1
      IF(J2-M)13,13,12
   12 J2=M
   13 JSEC=JSEC+1
      IF(JSEC-1)18,18,19
   18 PRINT17,TI,JSEC
   17 FORMAT(1H0,A6,9H SECTION I3/)
```

```
      GO TO 26
   19 PRINT20,TI,JSEC
   20 FORMAT(1H1,A6,9H SECTION I3/)
   26 PRINT27,(JX(I),I=J1,J2)
   27 FORMAT(6HO  ROW 3B,10I11)
      DO 29 I=1,M
      GO TO(231,242,253,264),INK
  231 PRINT 30,I,(SS(I,J),J=J1,J2)
      GO TO 29
  242 PRINT 30,I,(SSD(I,J),J=J1,J2)
      GO TO 29
  253 PRINT 30,I,( D(I,J),J=J1,J2)
      GO TO 29
  264 PRINT 30,I,( R(I,J),J=J1,J2)
   29 CONTINUE
   30 FORMAT(I6,4B,10F11.2)
      IF(J2-M)9,32,32
   32 GO TO (430,430,475,61),INK
      FND
      END
      JOBEND
      COMPILES
      SUBROUTINE EIGEND
      DIMENSIONSX(10),SSD(10,10),SS(10,10),D(10,10),R(10,10),
     1XM(10),SD(10),H(10,10),U(10,10)
      DIMENSIONIQ(10),X(10)
      COMMONSX,SSD,SS,D,R,XM,SD,H,U,M,NG,TITLE
      N=M
   10 DO14I=1,N
      DO14J=1,N
      IF(I-J)12,11,12
   11 U(I,J)=1.0
      GO TO 14
   12 U(I,J)=0.
   14 CONTINUE
   15 NR=0
      IF(N-1)1000,1000,17
   17 NMI1=N-1
      DO30I=1,NMI1
      X(I)=0.
      IPL1=I+1
      DO30J=IPL1,N
      IF(X(I)-ABSF(H(I,J)))20,20,30
   20 X(I)=ABSF(H(I,J))
      IQ(I)=J
   30 CONTINUE
      RAP=7.450580596E-9
      HDTEST=1.0E38
   40 DO70I=1,NMI1
      IF(I-1)60,60,45
   45 IF(XMAX-X(I))60,70,70
   60 XMAX=X(I)
      IPIV=I
      JPIV=IQ(I)
   70 CONTINUE
```

```
      GO TO 26
   19 PRINT20,TI,JSEC
   20 FORMAT(1H1,A6,9H SECTION I3/)
   26 PRINT27,(JX(I),I=J1,J2)
   27 FORMAT(6HO  ROW 3B,10I11)
      DO 29 I=1,M
      GO TO(231,242,253,264),INK
  231 PRINT 30,I,(SS(I,J),J=J1,J2)
      GO TO 29
  242 PRINT 30,I,(SSD(I,J),J=J1,J2)
      GO TO 29
  253 PRINT 30,I,( D(I,J),J=J1,J2)
      GO TO 29
  264 PRINT 30,I,( R(I,J),J=J1,J2)
   29 CONTINUE
   30 FORMAT(I6,4B,10F11.2)
      IF(J2-M)9,32,32
   32 GO TO (430,430,475,61),INK
      FND
      END
      JOBEND
      COMPILES
      SUBROUTINE EIGEND
      DIMENSIONSX(10),SSD(10,10),SS(10,10),D(10,10),R(10,10),
     1XM(10),SD(10),H(10,10),U(10,10)
      DIMENSIONIG(10),X(10)
      COMMONSX,SSD,SS,D,R,XM,SD,H,U,M,NG,TITLE
      N=M
   10 DO14I=1,M
      DO14J=1,N
      IF(I-J)12,11,12
   11 U(I,J)=1.0
      GO TO 14
   12 U(I,J)=0.
   14 CONTINUE
   15 NR=0
      IF(N-1)1000,1000,17
   17 NMI1=N-1
      DO30I=1,NMI1
      X(I)=0.
      IPL1=I+1
      DO30J=IPL1,N
      IF(X(I)-ABSF(H(I,J)))20,20,30
   20 X(I)=ABSF(H(I,J))
      IG(I)=J
   30 CONTINUE
      RAP=7.450580596E-9
      HDTEST=1.0E38
   40 DO70I=1,NMI1
      IF(I-1)60,60,45
   45 IF(XMAX-X(I))60,70,70
   60 XMAX=X(I)
      IPIV=I
      JPIV=IG(I)
   70 CONTINUE
```

```
      IF(XMAX)1000,1000,80
   80 IF(HDTEST)90,90,85
   85 IF(XMAX-HDTEST)90,90,148
   90 HDIMIN=ABSF(H(1,1))
      DO110I=2,N
      IF(HDIMIN-ABSF(H(I,I)))110,110,100
  100 HDIMIN=ABSF(H(I,I))
  110 CONTINUE
      HDTEST=HDIMIN*RAP
      IF(HDTEST-XMAX)148,1000,1000
  148 NR=NR+1
  150 TANG=SIGNF(2.0,(H(IPIV,IPIV)-H(JPIV,JPIV)))*H(IPIV,JPIV)/(ABSF(H(I
     1PIV,IPIV)-H(JPIV,JPIV))+SQRTF((H(IPIV,IPIV)-H(JPIV,JPIV))**2+4.0*H
     2(IPIV,JPIV)**2))
      COSINE=1.0/SQRTF(1.0+TANG**2)
      SINE=TANG*COSINE
      HII=H(IPIV,IPIV)
      H(IPIV,IPIV)=COSINE**2*(HII+TANG*(2.*H(IPIV,JPIV)+TANG*H(JPIV,
     1JPIV)))
      H(JPIV,JPIV)=COSINE**2*(H(JPIV,JPIV)-TANG*(2.*H(IPIV,JPIV)-
     1TANG*HII))
      H(IPIV,JPIV)=0.
      IF(H(IPIV,IPIV)-H(JPIV,JPIV))152,153,153
  152 HTEMP=H(IPIV,IPIV)
      H(IPIV,IPIV)=H(JPIV,JPIV)
      H(JPIV,JPIV)=HTEMP
      HTEMP=SIGNF(1.0,-SINE)*COSINE
      COSINE=ABSF(SINE)
      SINE=HTEMP
  153 CONTINUE
      DO350I=1,NMI1
      IF(I-IPIV)210,350,200
  200 IF(I-JPIV)210,350,210
  210 IF(IQ(I)-IPIV)230,240,230
  230 IF(IQ(I)-JPIV)350,240,350
  240 K=IQ(I)
  250 HTEMP=H(I,K)
      H(I,K)=0.
      IPL1=I+1
      X(I)=0.
      DO320J=IPL1,N
      IF(X(I)-ABSF(H(I,J)))300,300,320
  300 X(I)=ABSF(H(I,J))
      IQ(I)=J
  320 CONTINUE
      H(I,K)=HTEMP
  350 CONTINUE
      X(IPIV)=0.
      DO530I=1,N
      IF(I-IPIV)370,530,420
  370 HTEMP=H(I,IPIV)
      H(I,IPIV)=COSINE*HTEMP+SINE*H(I,JPIV)
      IF(X(I)-ABSF(H(I,IPIV)))380,390,390
  380 X(I)=ABSF(H(I,IPIV))
      IQ(I)=IPIV
```

```
 390 H(I,JPIV)=-SINE*HTEMP+COSINE*H(I,JPIV)
     IF(X(I)-ABSF(H(I,JPIV)))400,530,530
 400 X(I)=ABSF(H(I,JPIV))
     IG(I)=JPIV
     GOTO530
 420 IF(I-JPIV)430,530,480
 430 HTEMP=H(IPIV,I)
     H(IPIV,I)=COSINE*HTEMP+SINE*H(I,JPIV)
     IF(X(IPIV)-ABSF(H(IPIV,I)))440,450,450
 440 X(IPIV)=ABSF(H(IPIV,I))
     IG(IPIV)=I
 450 H(I,JPIV)=-SINE*HTEMP+COSINE*H(I,JPIV)
     IF(X(I)-ABSF(H(I,JPIV)))400,530,530
 480 HTEMP=H(IPIV,I)
     H(IPIV,I)=COSINE*HTEMP+  SINE*H(JPIV,I)
     IF(X(IPIV)-ABSF(H(IPIV,I)))490,500,500
 490 X(IPIV)=ABSF(H(IPIV,I))
     IG(IPIV)=I
 500 H(JPIV,I)=-SINE*HTEMP+COSINE*H(JPIV,I)
     IF(X(JPIV)-ABSF(H(JPIV,I)))510,530,530
 510 X(JPIV)=ABSF(H(JPIV,I))
     IG(JPIV)=I
 530 CONTINUE
 540 DO550I=1,N
     HTEMP=U(I,IPIV)
     U(I,IPIV)=COSINE*HTEMP+SINE*U(I,JPIV)
 550 U(I,JPIV)=-SINE*HTEMP+COSINE*U(I,JPIV)
     GOTO40
1000 RETURN
     END
     END
     JOBEND
     COMPILEX
TITLEAXRS49
     COMMONSX,SSD,SS,D,R,XM,SD,H,U,M,NG,TITLE
     DIMENSIONSX(10),SSD(10,10),SS(10,10),D(10,10),R(10,10),
    1XM(10),SD(10),H(10,10),U(10,10)
     DIMENSIONSUMT(10),W(10,10),T(10,10)
     DIMENSION TITLE(12),X(10)
     READ1,K,M
   1 FORMAT(2I2)
     PRINT2,K
   2 FORMAT(51H GENERALIZED ANALYSIS OF VARIANCE, NO. OF GROUPS = I2)
     EN=0.0
     EK=K
     FRASF(SUMT,W,T,H1LOGS,GA15,FA15)
     GROUPS=K
 100 READ 21,TT,NG
  21 FORMAT(F2.0,I5)
     READ22,(TITLE(I),I=1,12)
  22 FORMAT(12A6)
     PRINT22,(TITLE(I),I=1,12)
 210 M=TT
     ENG=NG
     DO230I=1,M
```

```
  220 SX(I)=0.0
      DO230J=1,M
  230 SS(I,J)=0.0
      CASES=ENG
  240 READ1001,(X(I),I=1,M)
      DO 241 I=1,M
      X(I)=ABSF(X(I))
  241 X(I)=LOGF(X(I))*0.43429448
 1001 FORMAT(3F8.0)
      DO260I=1,M
      SX(I)=SX(I)+X(I)
      DO260J=1,M
  260 SS(I,J)=SS(I,J)+X(I)*X(J)
C     RAW SUMS OF SQUARES AND CROSS PRODUCTS
      CASES=CASES-1.0
      IF(CASES)280,280,240
  280 DO286I=1,M
      DO286J=1,7
      SSD(I,J)=SS(I,J)-SX(I)*SX(J)/ENG
      SS(J,I)=SS(I,J)
  286 SSD(J,I)=SSD(I,J)
C     DEVIATION SUMS OF SQUARES AND CROSS PRODUCTS
      DO295I=1,M
      XM(I)=SX(I)/ENG
  295 SD(I)=SQRTF(SSD(I,I)/(ENG-1.0))
C     MEANS AND STANDARD DEVIATIONS
      PRINT31,(TITLE(I),I=1,12),TT,NG
   31 FORMAT(26H CORRELATION ANALYSIS FOR 12A6//
     123H NUMBER OF VARIABLES = ,F3.0//
     236H NUMBER OF SUBJECTS IN THIS GROUP = ,I5//)
      PRINT34,(XM(I),I=1,M)
   34 FORMAT(20H MEANS OF THIS GROUP//5F14.7)
      PRINT33,(SD(I),I=1,M)
   33 FORMAT(34H STANDARD DEVIATIONS OF THIS GROUP//5F14.7)
      CALL CORR
      ENG=NG
      EN=EN+ENG
      DO6I=1,M
    6 SUMT(I)=SUMT(I)+SX(I)
      DO7I=1,M
      DO7J=1,M
      W(I,J)=W(I,J)+SSD(I,J)
    7 T(I,J)=T(I,J)+SS(I,J)
C
      DO70J=1,M
      DO70I=1,M
   70 H(I,J)=D(I,J)
      CALLEIGEND
      DO71J=1,M
      DO71I=1,M
      SS(I,J)=U(I,J)
   71 D(I,J)=H(I,J)
      DETERM=0.0
      DO8I=1,M
    8 DETERM=DETERM+LOGF(D(I,I))
```

```
      PRINT9,DETERM
    9 FORMAT(29H LOG DETERMINANT OF GROUP D = F14.7)
      DET=EXPF(DETERM)
      PRINT91,DET
   91 FORMAT(17H DETERMINANT D = F14.7)
      H1LOG=(ENG-1.0)*DETERM
      PRINT10,H1LOG
   10 FORMAT(24H H1LOG FOR THIS GROUP = F14.7)
      H1LOGS=H1LOGS+H1LOG
      FA1=1.0/(ENG-1.0)
      PRINT11,FA1
   11 FORMAT(22H FA1 FOR THIS GROUP = F14.7)
      FA1S=FA1S+FA1
      GA1=1.0/((ENG-1.0)**2.0)
      PRINT12,GA1
   12 FORMAT(22H GA1 FOR THIS GROUP = F14.7)
      GA1S=GA1S+GA1
      GROUPS=GROUPS-1.0
      IF(GROUPS)35,35,100
C     GROUP DISPERSIONS AND T AND W ARE DONE
   35 CONTINUE
   25 FORMAT(5F14.7)
      DO36I=1,M
      DO36J=1,M
      SSD(I,J)=W(I,J)
      SS(I,J)=T(I,J)
   36 T(I,J)=SS(I,J)-(SUMT(I)*SUMT(J)/EN)
C     T(I,J) IS NOW THE TOTAL DEVIATION CROSS PRODUCTS MATRIX
      DO37J=1,M
      DO37I=1,M
   37 H(I,J)=SSD(I,J)
      CALLEIGEND
      DO371J=1,M
      DO371I=1,M
      D(I,J)=U(I,J)
  371 SSD(I,J)=H(I,J)
      DETERM=0.0
      DO38I=1,M
   38 DETERM=DETERM+LOGF(SSD(I,I))
      PRINT381,DETERM
  381 FORMAT(31H LOG DETERMINANT OF POOLED W = F14.7)
      DET=EXPF(DETERM)
      PRINT391,DET
  391 FORMAT(17H DETERMINANT W = F19.7)
      EM=M
      WATE=LOGF(EN-EK)*EM
      PRINT382,WATE
  382 FORMAT(10H WEIGHT = F14.7)
      H1LOG=(DETERM-WATE)*(EN-EK)
      PRINT383,H1LOG
  383 FORMAT(9H H1LOG = F14.7)
      XMM=H1LOG-H1LOGS
      F1=.5*(EK-1.0)*EM*(EM+1.0)
      A1A=(FA1S-(1.0/(EN-EK)))*((2.0*(EM**2.0))+(3.0*EM)-1.0)
      A1=A1A/(6.0*(EK-1.0)*(EM+1.0))
```

```
      A2=(GA1S-(1.0/(EN-FK)*2.0))*((FM-1.0)*(EM+2.0))/(6.0*(EK-1.0))
      DIF=A2-(A1**2.0)
      PRINT39,XMM,F1,DIF
   39 FORMAT(22H FOR TEST OF H1    M = F14.7//6H F1 = F
     X14.7//19H A2 - A1 SQUARED = F14.7)
      IF(DIF)42,42,442
   42 F2=(F1+2.0)/((A1**2.0)-A2)
      B=F2/(1.0-A1+(2.0/F2))
      F=F2*XMM /(F1*(B-XMM))
      GOTO443
  442 F2=(F1+2.0)/DIF
      B=F1/(1.0-A1-(F1/F2))
      F=XMM/B
  443 PRINT43,F2,F,A1,A2,B
   43 FORMAT(6H F2 = F14.7//21H FOR TEST OF H1, F = F14.7//
     X6H A1 = F14.7//6H A2 = F14.7//5H B = F14.7)
   44 DO45I=1,M
      DO45J=1,M
   45 D(I,J)=T(I,J)/(EN-1.0)
C     D(I,J) IS NOW THE TOTAL VARIANCE COVARIANCE MATRIX.
      DO450I=1,M
      DO450J=1,M
  450 R(I,J)=T(I,J)/SQRTF(T(I,I)*T(J,J))
      DO46I=1,M
      XM(I)=SUMT(I)/EN
   46 SD(I)=SQRTF(D(I,I))
      PRINT47
   47 FORMAT(22H MEANS OF TOTAL SAMPLE)
      PRINT25,(XM(I),I=1,M)
      PRINT48
   48 FORMAT(37H STANDARD DEVIATIONS FOR TOTAL SAMPLE)
      PRINT25,(SD(I),I=1,M)
      PRINT49
   49 FORMAT(44H VARIANCE-COVARIANCE MATRIX FOR TOTAL SAMPLE)
   50 PRINT25,((D(I,J),I=1,M),J=1,M)
      PRINT52
   52 FORMAT(36H CORRELATION MATRIX FOR TOTAL SAMPLE)
   53 PRINT25,((R(I,J),I=1,M),J=1,M)
C
      DO54J=1,M
      DO54I=1,M
   54 H(I,J)=T(I,J)
      CALLEIGEND
      DO55J=1,M
      DO55I=1,M
      D(I,J)=U(I,J)
   55 T(I,J)=H(I,J)
      DETERT=0.0
      DO57I=1,M
   57 DETERT=DETERT+LOGF(T(I,I))
      DET=EXPF(DETERT)
      PRINT571,DETERT,DET
  571 FORMAT(24H LOG DETERMINANT OF T = F19.7//
     X17H DETERMINANT T = F19.7)
      XLAMBI=DETERM-DETERT
```

```
      XLAMB=EXPF(XLAMBL)
      IF(EM-2.0)573,573,574
  573 F1=2.0*(EK-1.0)
      F2=2.0*(EN-EK-1.0)
      Y=SQRTF(XLAMB)
      F=(1.0-Y)*F2/(Y*F1)
      GOTO579
  574 S=SQRTF(((EM**2)*((EK-1.0)**2)-4.0)/((EM**2)+((EK-1.0)**2)-5.0))
      IF(S)575,575,576
  575 F1=EK-1.0
      F2=EN-EK
      F=((1.0-XLAMB)/XLAMB)*(F2/F1)
      GOTO579
  576 Y=XLAMB**(1.0/S)
      XM1=(EN-1.0)-((EM+EK)/2.0)
      XL=-((EM*(EK-1.0))-2.0)/4.0
      R1=(EM*(EK-1.0))/2.0
      F1=2.0*R1
      F2=(XM1*S)+(2.0*XL)
      F=((1.0-Y)/Y)*(F2/F1)
  579 PRINT58,XLAMB,F1,F2,F
   58 FORMAT(9H LAMBDA= F14.7//6H F1 = F14.7//6H F2 = F14.7//
     X21H FOR TEST OF H2, F = F14.7)
      STOP
      END
      END
      OVERLAY
      STACKEIGEND
      STACKCORR
      JOBEND
```

SAMPLE INPUT & OUTPUT

```
0303
0300005
                                        LOCATION    1
89000.      16000.      25.
46000.      7600.       1.
76000.      300.        7.
69000.      2600.       7.
300000.     13000.      2.
0300005
                                        LOCATION    2
11000.      8000.       17.
11000.      4700.       42.
61000.      2800.       2.
5200.       300.        1400.
18000.      300.        51.
0300005
                                        LOCATION    3
92000.      1100.       3.
50000.      2100.       36.
240000.     1400.       1.
590000.     3800.       4.
140000.     2200.       6.

CARDS  438
```

GENERALIZED ANALYSIS OF VARIANCE. NO. OF GROUPS = 3
LOCATION 1
CORRELATION ANALYSIS FOR LOCATION 1

NUMBER OF VARIABLES = 3.

NUMBER OF SUBJECTS IN THIS GROUP = 5

MEANS OF THIS GROUP

4.9617863 3.6181943 0.6778332
STANDARD DEVIATIONS OF THIS GROUP

0.3069251 0.7073527 0.5422055
RAW SUMS OF SQUARES AND CROSS PRODUCTS
500200 SECTION 1

ROW	1	2	3
1	123.47	90.05	16.78
2	90.05	67.46	12.09
3	16.78	12.09	3.47

VARIANCE-COVARIANCE MATRIX
500200 SECTION 1

ROW	1	2	3
1	0.09	0.07	-0.01
2	0.07	0.50	-0.04
3	-0.01	-0.04	0.29

CORRELATION MATRIX . LOCATION 1
500200 SECTION 1

ROW	1	2	3
1	1.00	0.33	-0.05
2	0.33	1.00	-0.11
3	-0.05	-0.11	1.00
MEANS	4.96	3.62	0.68
STD DEV	0.31	0.71	0.54

LOG DETERMINANT OF GROUP D = -4.4069946
DETERMINANT D = 0.0121918
H1LOG FOR THIS GROUP = -17.6279782
FA1 FOR THIS GROUP = 0.2500000
GA1 FOR THIS GROUP = 0.0625000
LOCATION 2
CORRELATION ANALYSIS FOR LOCATION 2

NUMBER OF VARIABLES = 3.

NUMBER OF SUBJECTS IN THIS GROUP = 5

MEANS OF THIS GROUP

4.1678782 3.1953177 1.6016853

STANDARD DEVIATIONS OF THIS GROUP

0.3953076 0.6751475 1.0279227

RAW SUMS OF SQUARES AND CROSS PRODUCTS
/W/ 00 SECTION 1

ROW	1	2	3
1	87.48	66.86	31.93
2	66.86	52.87	23.82
3	31.93	23.82	17.05

VARIANCE-COVARIANCE MATRIX
/W/ 00 SECTION 1

ROW	1	2	3
1	0.16	0.07	-0.36
2	0.07	0.46	-0.44
3	-0.36	-0.44	1.06

CORRELATION MATRIX , LOCATION 2
/W/ 00 SECTION 1

ROW	1	2	3
1	1.00	0.25	-0.89
2	0.25	1.00	-0.64
3	-0.89	-0.64	1.00
MEANS	4.17	3.20	1.60
STD DEV	0.40	0.68	1.03

LOG DETERMINANT OF GROUP D = -6.3374859
DETERMINANT D = 0.0017687
H1LOG FOR THIS GROUP = -25.3499435
FA1 FOR THIS GROUP = 0.2500000
GA1 FOR THIS GROUP = 0.0625000
LOCATION 3
CORRELATION ANALYSIS FOR LOCATION 3

NUMBER OF VARIABLES = 3.

NUMBER OF SUBJECTS IN THIS GROUP = 5

MEANS OF THIS GROUP

5.1919898 3.2863892 0.6827270

STANDARD DEVIATIONS OF THIS GROUP

0.4085819 0.2062767 0.5672603

RAW SUMS OF SQUARES AND CROSS PRODUCTS

```
/W/ 00 SECTION    1


  ROW              1           2           3

    1          135.45       85.49       17.16
    2           85.49       54.17       11.38
    3           17.16       11.38        3.62
VARIANCE-COVARIANCE MATRIX
/W/ 00 SECTION    1


  ROW              1           2           3

    1            0.17        0.04       -0.14
    2            0.04        0.04        0.04
    3           -0.14        0.04        0.32
CORRELATION MATRIX .                                  LOCATION    3
/W/ 00 SECTION    1


  ROW              1           2           3

    1            1.00        0.53       -0.61
    2            0.53        1.00        0.34
    3           -0.61        0.34        1.00
MEANS            5.19        3.29        0.68
STD DEV          0.41        0.21        0.57
LOG DETERMINANT OF GROUP D =    -10.3906692
DETERMINANT D =       0.0000307
H1LOG FOR THIS GROUP =     -41.5626770
FA1 FOR THIS GROUP =       0.2500000
GA1 FOR THIS GROUP =       0.0625000
LOG DETERMINANT OF POOLED W =       3.1936105
DETERMINANT W =           24.3762791
WEIGHT =       7.4547200
H1LOG =     -51.1333135
FOR TEST OF H1    M =      33.4072852

F1 =      12.0000000

A2 - A1 SQUARED =      -0.1130401
F2 =     123.8498301

FOR TEST OF H1. F =       2.2149437

A1 =       0.3611111

A2 =       0.0173611

B =     189.0728913
MEANS OF TOTAL SAMPLE
     4.7738848      3.3666337      0.9874152
STANDARD DEVIATIONS FOR TOTAL SAMPLE
     0.5704920      0.5663318      0.8246039
VARIANCE-COVARIANCE MATRIX FOR TOTAL SAMPLE
```

```
    0.3254611      0.0943781     -0.3453174      0.0943781      0.3207317
   -0.1833733     -0.3453174     -0.1833733      0.6799717
CORRELATION MATRIX FOR TOTAL SAMPLE
    1.0000000      0.2921129     -0.7340464      0.2921129      1.0000000
   -0.3926629     -0.7340464     -0.3926629      1.0000000
LOG DETERMINANT OF T =              4.3303371

DETERMINANT T =           75.9698948
LAMBDA=       0.3208676

F1 =       6.0000000

F2 =      20.0000000

FOR TEST OF H2, F =       2.5512511
```

AXRS59

GENERAL ROUTINE AXRS59
NUMERICAL INTEGRATION - TRAPEZOIDAL RULE

T. A. Entzminger

PURPOSE: Computes the area under a curve having the form

g = f(x) from x = o to n

$$A = \int_{o}^{n} f(x)\, dx$$

RESTRICTIONS: 1) Function may have a maximum of 5 constant values.

2) Program deck must be recompiled for each new function by using a programmer defined function statement.

ACCURACY: Single precision floating point with eight significant digits.

INPUT:

Control card	Card Column
1st constant	1-10
2nd constant	11-20
3rd constant	21-30
4th constant	31-40
5th constant	41-50
Intervals for calculations	51-60
Maximum value of the argument (n)	61-70
Interval for printing	71-80

OUTPUT: Program prints the argument (x) and the corresponding area under the curve between limits o to n at each print interval designated by the input.

```
      COMPLEX
 TITLEAXRS59
C      NUMERICAL INTEGRATION TRAPEZOIDAL RULE
     1 READ 1000,C1,C2,C3,C4,C5,H,XMAX,PRIN
       IF END OF FILE 7,10
    10 KTR=0
       PRINT3000
       X=0.0
       PMAX=PRIN
       FUNA=FUNF(C1,C2,C3,C4,C5,X)/2.0
       FUNT=FUNA
     2 X=X+H
       FUNB=FUNF(C1,C2,C3,C4,C5,X)
       IF(X-XMAX)3,6,6
     3 IF(X-PMAX)5,4,4
     5 FUNT=FUNT+FUNB
       GO TO 2
     6 KTR=1
     4 FUNP=(FUNT+FUNB/2.0)*H-(FUNB-FUNA)/12.0*H**2
       PMAX=X+PRIN
       PRINT 2000,X,FUNP
       IF(KTR-1)5,1,1
     7 TYPE,8
     8 FORMAT(8HEND  JOB)
       STOP
  1000 FORMAT(8F10.0)
  2000 FORMAT(20B,E16.9,20B,E16.9)
  3000 FORMAT(1H1/40B,21HNUMERICAL INTEGRATION//20B,8HARGUMENT20B,
      116HAREA UNDER CURVE//)
       FUNF(C1,C2,C3,C4,C5,X)=SINF(X)
       END
       END
       JOBEND


                    INPUT TEST DATA

                                                    .001      3.1415927 .05
 FINIS


CARDS  041
```

NUMERICAL INTEGRATION

ARGUMENT	AREA UNDER CURVE
0.500000000E-01	0.124973533E-02
0.100000000E 00	0.499582596E-02
0.150000000E 00	0.112289086E-01
0.200000000E 00	0.199334036E-01
0.250000000E 00	0.310875545E-01
0.300000000E 00	0.446634816E-01
0.350000000E 00	0.606272524E-01
0.400000000E 00	0.789389656E-01
0.450000000E 00	0.995528514E-01
0.500000000E 00	0.122417384E 00
0.550000000E 00	0.147475416E 00
0.600000000E 00	0.174664315E 00
0.650000000E 00	0.203916123E 00
0.700000000E 00	0.235157726E 00
0.750000000E 00	0.268311036E 00
0.800000000E 00	0.303293187E 00
0.850000000E 00	0.340016743E 00
0.900000000E 00	0.378389912E 00
0.950000000E 00	0.418316782E 00
0.100000000E 01	0.459697557E 00
0.105000000E 01	0.502428807E 00
0.110000000E 01	0.546403725E 00
0.115000000E 01	0.591512397E 00
0.120000000E 01	0.637642076E 00
0.125000000E 01	0.684677460E 00
0.130000000E 01	0.732500986E 00
0.135000000E 01	0.780993120E 00
0.140000000E 01	0.830032657E 00
0.145000000E 01	0.879497023E 00
0.150000000E 01	0.929262583E 00
0.155000000E 01	0.979204950E 00
0.160000000E 01	0.102919928E 01
0.165000000E 01	0.107912062E 01
0.170000000E 01	0.112884420E 01
0.175000000E 01	0.117824573E 01
0.180000000E 01	0.122720174E 01
0.185000000E 01	0.127558986E 01
0.190000000E 01	0.132328915E 01
0.195000000E 01	0.137018039E 01
0.200000000E 01	0.141614637E 01
0.205000000E 01	0.146107220E 01
0.210000000E 01	0.150484558E 01
0.215000000E 01	0.154735711E 01
0.220000000E 01	0.158850054E 01
0.225000000E 01	0.162817301E 01
0.230000000E 01	0.166627539E 01
0.235000000E 01	0.170271242E 01
0.240000000E 01	0.173739304E 01
0.245000000E 01	0.177023055E 01
0.250000000E 01	0.180114289E 01
0.255000000E 01	0.183005278E 01

0.260000000E 01	0.185688798E 01
0.265000000E 01	0.188158140E 01
0.270000000E 01	0.190407132E 01
0.275000000E 01	0.192430153E 01
0.280000000E 01	0.194222147E 01
0.285000000E 01	0.195778635E 01
0.290000000E 01	0.197095726E 01
0.295000000E 01	0.198170127E 01
0.300000000E 01	0.198999155E 01
0.305000000E 01	0.199580735E 01
0.310000000E 01	0.199913415E 01
0.314200000E 01	0.199999890E 01

AXRS68

GENERAL ROUTINE AXRS68
TIME SERIES ANALYSIS AUTOCOVARIANCE, AUTOCORRELATION AND POWER SPECTRAL ANALYSIS

PURPOSE: This program computes the autocovariance, autocorrelation, power spectrum, cross-variance, cross-correlation and co-spectrum of time series.

RESTRICTIONS: 1) Card Input

2) 500 discrete data pairs

3) Maximum of 100 lags

ACCURACY: Single precision floating point computations with eight significant digits.

OPTIONS: Transformation of a variable can be made by inserting the proper statements between the transform comment cards in the source deck.

INPUT: Standard card format is seven fields of ten digits each; the last ten digits are used for identification.

CARD DECK SETUP:

1. Execute card
2. Program Desk (Binary)
3. Control Card - Total number of observations of variable pairs in card columns 1-3 and the maximum lag wanted in columns 4-6. A time interval (usually 1.0) appears in columns 7-17.
4. Data cards
5. FINIS card

OUTPUT:

1. Printout of input data
2. Printout of autocorrelations
3. Printout of autocovariance
4. Printout of power spectral estimates
5. Printout of cross-correlations
6. Printout of cross-covariances
7. Printout of co-spectra

DESCRIPTION & PROGRAM LISTING

```
      COMPILEX
 TITLEAXRS68
      DIMENSIONW2( 51),W3( 51),W4( 51),W1( 51),X(1000),
     1Y(1000),      POW1( 50),POW2( 50),POW3( 50),SP1( 50),
     2SP2( 50),SP3( 50),C1( 50),C2( 50),C3( 50),C4( 50)
      EQUIVALENCE(X(1),POW1),(X( 51),POW2),(X(101),POW3),
     1(X(151),SP1),(X(201),SP2),(Y(1),SP3)
      READ1000,N,M,DELT
      PRINT 3002
      READ 1001,(X(I),I=1,N)
      PRINT 1002,(X(I),I=1,N)
      READ 1001,(Y(I),I=1,N)
      PRINT 1002,(Y(I),I=1,N)
      ASSIGN 40 TO ISIGN
      IFORK=0
 1001 FORMAT(4B,15F4.1)
 1002 FORMAT(10F10.1)
      ERASE(TX,TY,CXY,C1,C2,C3,C4,SSX,SSY)
      EM=M
      MP1=M+1
      DO6I=1,N
      TX=X(I)+TX
    6 TY=Y(I)+TY
      AN=N
      AVGX=TX/AN
      AVGY=TY/AN
      DO3I=1,N
      X(I)=X(I)-AVGX
    3 Y(I)=Y(I)-AVGY
      DO16I=1,N
      CXX=CXX+X(I)*X(I)
      CYY=CYY+Y(I)*Y(I)
   16 CXY=CXY+X(I)*Y(I)
      DO30IP=1,M
      NMIP=N-IP
      DO26I=1,NMIP
      IPIP=I+IP
C     POSITIVE TAU
      C3(IP)=C3(IP)+X(I)*Y(IPIP)
      C2(IP)=C2(IP)+Y(I)*Y(IPIP)
      C1(IP)=C1(IP)+X(I)*X(IPIP)
C     NEGATIVE TAU
   26 C4(IP)=C4(IP)+Y(I)*X(IPIP)
      FMIP=NMIP
      W1(IP+1)=C1(IP)/FMIP
      W2(IP+1)=C2(IP)/FMIP
      W3(IP+1)=C3(IP)/FMIP
   30 W4(IP+1)=C4(IP)/FMIP
      W1(1 )=CXX/AN
      W2(1 )=CYY/AN
      W3(1 )=CXY/AN
      W4(1 )=W3(1 )
      PRINT 1011
      PRINT 1008
      PRINT1009,(W1(I),W2(I),W3(I),W4(I),I=1,MP1)
```

```
      PI=3.1415927
C
C     CALCULATE RAW ESTIMATES
C
      TERM2=2.0*DELT/PI
    2 ERASE(POW1,POW2,POW3)
      H=-1.0
      DO10IH=1,MP1
      H=H+1.0
      DO9IP=1,MP1
      P=IP-1
      IF(IP-1)4,5,4
    5 EP=0.5
      GO TO 8
    4 IF(IP-MP1)7,5,7
    7 EP=1.0
    8 TERM=COSF(H*P*PI/EM)
      POW1(IH)=POW1(IH)+EP*W1(IP)*TERM
      POW2(IH)=POW2(IH)+EP*W2(IP)*TERM
    9 POW3(IH)=POW3(IH)+EP*(W3(IP)+W4(IP))*TERM
      POW1(IH)=POW1(IH)*TERM2
      POW2(IH)=POW2(IH)*TERM2
   10 POW3(IH)=POW3(IH)*DELT/PI
      DO15IH=1,MP1
      IF(IH-1)12,11,12
   11 SP1(IH)=.54*POW1(IH)+.46*POW1(IH+1)
      SP2(IH)=.54*POW2(IH)+.46*POW2(IH+1)
      SP3(IH)=.54*POW3(IH)+.46*POW3(IH+1)
      GO TO 15
   12 IF(IH-MP1)14,13,14
   13 SP1(IH)=.54*POW1(IH)+.46*POW1(IH-1)
      SP2(IH)=.54*POW2(IH)+.46*POW2(IH-1)
      SP3(IH)=.54*POW3(IH)+.46*POW3(IH-1)
      GO TO 15
   14 SP1(IH)=.23*POW1(IH-1)+.54*POW1(IH)+.23*POW1(IH+1)
      SP2(IH)=.23*POW2(IH-1)+.54*POW2(IH)+.23*POW2(IH+1)
      SP3(IH)=.23*POW3(IH-1)+.54*POW3(IH)+.23*POW3(IH+1)
   15 CONTINUE
      PRINT1004
      COUNT=-1.0
      DO20I=1,MP1
      COUNT=COUNT+1.0
   20 PRINT1005,COUNT,POW1(I),POW2(I),POW3(I)
      PRINT1007
      COUNT=-1.0
      DO21I=1,MP1
      COUNT=COUNT+1.0
   21 PRINT1006,COUNT,SP1(I),SP2(I),SP3(I)
      GO TOISIGN,(40,41)
   40 ASSIGN 41 TO ISIGN
C
C      COMPUTE AUTO CORRELATION COEFFICIENTS
C
      T1=SQRTF(W1(1) )*SQRTF(W2(1))
      T2=W2(1)
```

```
      T3=W1(1)
      DO 31 I=1,MP1
      W1(I)=W1(I)/T3
      W2(I)=W2(I)/T2
      W3(I)=W3(I)/T1
   31 W4(I)=W4(I)/T1
      PRINT 1011
 1011 FORMAT(1H1)
      PRINT 1010
      PRINT1009,(W1(I),W2(I),W3(I),W4(I),I=1,MP1)
      IFORK=1
      GO TO 2
   41 TYPE,1003
 1003 FORMAT(8H JOB END)
      STOP
 1004 FORMAT(1H1/10B22HRAW SPECTRAL ESTIMATES//
     118B3HLAG10B16HPOWER SPECTRUM 1
     25B16HPOWER SPECTRUM 26B10HCO SPECTRA//)
 1007 FORMAT(1H1/10B27HSMOOTHED SPECTRAL ESTIMATES//
     118B3HLAG10B16HPOWER SPECTRUM 1
     25B16HPOWER SPECTRUM 26B10HCO SPECTRA//)
 1008 FORMAT(14B37HAUTO COVARIANCE 1   AUTO COVARIANCE 2
     113B16HCROSS COVARIANCE/56B12HPOSITIVE TAU8B12HNEGATIVE TAU//)
 1010 FORMAT(14B38HAUTO CORRELATION 1  AUTO CORRELATION 2
     112B17HCROSS CORRELATION/56B12HPOSITIVE TAU8B12HNEGATIVE TAU//)
 1005 FORMAT(10B4E20.9)
 1006 FORMAT(10B4E20.9)
 1009 FORMAT(10B4E20.9)
 1000 FORMAT(2I3,F10.0)
 3002 FORMAT(1H1/40B23HPOWER SPECTRUM ANALYSIS////10B10HINPUT DATA//)
      FND
      END
      JOBEND
```

SAMPLE INPUT & OUTPUT

INPUT TEST DATA

```
075030  1.0
0061 070 069 062 061 063 062 062 059 060 059 059 059 061 065 066              U11
0062 066 066 066 066 069 066 064 064 063 060 059 066 071 074 079              U11
0063 083 088 086 086 084 086 091 093 092 095 094 092 087 079 079              U11
0064 080 078 087 091 086 083 088 090 089 086 088 082 075 069 060              U11
0071 064 062 062 062 062 062 063 066 072 076 085 084 083 083 085              U11
0061 320 482 482 376 362 415 374 451 565 498 430 429 444 444 405              A22
0062 380 478 500 255 349 454 470 461 439 410 410 409 424 292 437              A22
0063 376 386 307 356 375 408 474 504 438 440 429 416 413 447 479              A22
0064 485 509 499 530 402 394 411 435 471 411 544 480 435 457 440              A22
0071 434 448 423 403 525 699 438 438 351 356 389 436 367 461 416              A22
 FINIS


CARDS  161
```

POWER SPECTRUM ANALYSIS

INPUT DATA

7.0	6.9	6.2	6.1	6.3	6.2	6.2	5.9	6.0	5.9
5.9	5.9	6.1	6.5	6.6	6.6	6.6	6.6	6.6	6.9
6.6	6.4	6.4	6.3	6.0	5.9	6.6	7.1	7.4	7.9
8.3	8.8	8.6	8.6	8.4	8.6	9.1	9.3	9.2	9.5
9.4	9.2	8.7	7.9	7.9	8.0	7.8	8.7	9.1	8.6
8.3	8.8	9.0	8.9	8.6	8.8	8.2	7.5	6.9	6.0
6.4	6.2	6.2	6.2	6.2	6.2	6.3	6.6	7.2	7.6
8.5	8.4	8.3	8.3	8.5					
32.0	48.2	48.2	37.6	36.2	41.5	37.4	45.1	56.5	49.8
43.0	42.9	44.4	44.4	40.5	38.0	47.8	50.0	25.5	34.9
45.4	47.0	46.1	43.9	41.0	41.0	40.9	42.4	29.2	43.7
37.6	38.6	30.7	35.6	37.5	40.8	47.4	50.4	43.8	44.0
42.9	41.6	41.3	44.7	47.9	48.5	50.9	49.9	53.0	40.2
39.4	41.1	43.5	47.1	41.1	54.4	48.0	43.5	45.7	44.0
43.4	44.8	42.3	40.3	52.5	69.9	43.8	43.8	35.1	35.6
38.9	43.6	36.7	46.1	41.6					

AUTO COVARIANCE 1	AUTO COVARIANCE 2	CROSS COVARIANCE POSITIVE TAU	CROSS COVARIANCE NEGATIVE TAU
0.134397155E 01	0.411686219E 02	-0.402924444E 00	-0.402924444E 00
0.128772394E 01	0.125936120E 02	-0.274706186E 00	-0.824825105E 00
0.118785858E 01	-0.601929915E-01	-0.110335467E-01	-0.857645418E 00
0.106697289E 01	-0.139784444E 01	0.661352222E 00	-0.704453333E 00
0.926484780E 00	-0.138911048E 01	0.104973196E 01	-0.699770391E 00
0.777291300E 00	-0.442180318E 01	0.125192063E 01	-0.246959364E 00
0.645145351E 00	0.621899518E 00	0.167927807E 01	-0.155587632E 00
0.534963738E 00	0.847220915E 00	0.256374601E 01	-0.961265348E-01
0.435451329E 00	0.310527828E 01	0.289994534E 01	-0.345720331E 00
0.334573899E 00	0.595654950E 01	0.293843555E 01	-0.312614949E 00
0.241806906E 00	0.467067008E 01	0.288775521E 01	-0.624923760E 00
0.162547195E 00	-0.342359096E 01	0.256867444E 01	-0.975160971E 00
0.120453842E 00	0.132452064E 01	0.228564613E 01	-0.121850201E 01
0.110245650E 00	-0.254345018E 01	0.222974595E 01	-0.156428416E 01
0.111049210E 00	-0.292119493E 00	0.200037362E 01	-0.139791709E 01
0.116239556E 00	-0.109472223E 01	0.200691999E 01	-0.121884000E 01
0.119874773E 00	-0.509011375E 01	0.239618545E 01	-0.135245183E 01
0.876836172E-01	-0.178546130E 01	0.233367157E 01	-0.141999739E 01
0.370506667E-01	0.481672281E 01	0.179625778E 01	-0.127046971E 01
-0.487167929E-01	0.329904444E 01	0.106287683E 01	-0.154963746E 01
-0.154606707E 00	-0.213984647E 01	0.846720808E 00	-0.186866343E 01
-0.255023407E 00	-0.175472099E 01	0.736472592E 00	-0.177900395E 01
-0.378275957E 00	-0.443945241E 01	0.104716847E 01	-0.154752084E 01
-0.525489503E 00	-0.843436582E 01	0.160928598E 01	-0.129788837E 01
-0.677331031E 00	-0.685608626E 01	0.205116497E 01	-0.552390587E 00
-0.800531553E 00	-0.568122222E 01	0.228047645E 01	0.185505779E 00
-0.925881757E 00	-0.352557459E 01	0.200327002E 01	0.513865943E 00
-0.103444655E 01	-0.267778888E 01	0.120359944E 01	0.547774446E 00
-0.108059850E 01	0.796081040E 01	0.915403876E 00	0.842064871E 00
-0.105404402E 01	0.147468213E 01	0.309973720E 00	0.669744737E 00
-0.100200414E 01	-0.460577778E 01	-0.517208889E 00	0.806518520E 00

RAW SPECTRAL ESTIMATES

LAG	POWER SPECTRUM 1	POWER SPECTRUM 2	CO SPECTRA
0.000000000E 00	0.980047562E 00	0.505792247E 01	0.826002837E 01
0.100000000E 01	0.881128685E 01	0.336283569E 02	-0.558702618E 00
0.200000000E 01	-0.199075483E 00	0.177665045E 02	-0.158408633E 00
0.300000000E 01	0.262068719E 01	0.544467795E 01	-0.605685541E 01
0.400000000E 01	0.526573766E 00	0.272686398E 02	-0.211007279E 01
0.500000000E 01	-0.798280057E-01	0.184126674E 01	-0.376337828E 00
0.600000000E 01	0.238576838E 00	0.438838671E 02	-0.247220091E 01
0.700000000E 01	0.852581304E-01	0.300746600E 02	0.335347283E 01
0.800000000E 01	0.219045312E 00	0.132999443E 02	-0.567276577E 00
0.900000000E 01	-0.928551069E-01	0.260085964E 02	-0.500709203E 00
0.100000000E 02	0.587225791E-01	0.100071314E 02	0.107297245E 00
0.110000000E 02	-0.546707458E-01	0.104755052E 02	-0.236162190E-01
0.120000000E 02	0.574164016E-01	0.812977282E 01	-0.676891327E-01
0.130000000E 02	-0.350748341E-01	0.285901663E 02	-0.312317845E-01
0.140000000E 02	0.929440848E-01	0.925531447E 01	0.153527185E 00
0.150000000E 02	-0.356738649E-01	0.114659656E 02	0.203372590E 00
0.160000000E 02	0.494651427E-01	0.527161593E 01	-0.768807726E-01
0.170000000E 02	-0.503370567E-02	0.216627062E 02	0.570575963E 00
0.180000000E 02	0.181229710E-01	-0.122484155E 01	-0.160270514E 00
0.190000000E 02	0.132546437E-01	0.209020315E 02	0.457357964E 00
0.200000000E 02	0.109502391E-01	0.139148756E 02	-0.101753709E 00
0.210000000E 02	-0.128477986E-01	0.965566924E 01	0.186736951E 00
0.220000000E 02	0.164563278E-01	-0.148126158E 01	-0.166718740E 00
0.230000000E 02	0.331536625E-02	0.501665321E 01	0.199004696E 00
0.240000000E 02	0.114848712E-01	0.464321528E 01	0.108841576E 00
0.250000000E 02	-0.107112923E-01	0.945258720E 01	0.143228990E 00
0.260000000E 02	0.194361002E-01	0.602108585E 01	0.173606870E 00
0.270000000E 02	-0.739695123E-02	-0.140123552E 01	0.680751459E-01
0.280000000E 02	0.642912749E-02	0.700341960E 01	-0.503536026E-01
0.290000000E 02	0.150132256E-02	0.573906102E 01	-0.248871020E 00
0.300000000E 02	0.123983201E-01	0.165729240E 02	0.503845590E-01

SMOOTHED SPECTRAL ESTIMATES

LAG	POWER SPECTRUM 1	POWER SPECTRUM 2	CO SPECTRA
0.000000000E 00	0.458241763E 01	0.182003223E 02	0.420341211E 01
0.100000000E 01	0.494001848E 01	0.234089309E 02	0.156167313E 01
0.200000000E 01	0.252725327E 01	0.185807104E 02	-0.160711901E 01
0.300000000E 01	0.149279569E 01	0.132982093E 02	-0.379245265E 01
0.400000000E 01	0.868747445E 00	0.164008328E 02	-0.261907375E 01
0.500000000E 01	0.132877516E 00	0.173593606E 02	-0.125714538E 01
0.600000000E 01	0.130080421E 00	0.310379514E 02	-0.650247439E 00
0.700000000E 01	0.151292485E 00	0.293925930E 02	0.111179551E 01
0.800000000E 01	0.116537164E 00	0.200811189E 02	0.349806283E 00
0.900000000E 01	0.137448573E-01	0.194052694E 02	-0.376178216E 00
0.100000000E 02	-0.222075338E-02	0.137951943E 02	-0.626543348E-01
0.110000000E 02	-0.281023719E-02	0.982826077E 01	-0.364289246E-02
0.120000000E 02	0.103633735E-01	0.133751818E 02	-0.491671725E-01
0.130000000E 02	0.156425014E-01	0.194372599E 02	0.287758829E-02
0.140000000E 02	0.339176050E-01	0.142107801E 02	0.122497065E 00
0.150000000E 02	0.134902353E-01	0.953281542E 01	0.127449873E 00
0.160000000E 02	0.173484358E-01	0.104662671E 02	0.136492550E 00
0.170000000E 02	0.128270651E-01	0.126286195E 02	0.253566224E 00
0.180000000E 02	0.116772201E-01	0.912847523E 01	0.149878726E 00
0.190000000E 02	0.138443459E-01	0.142058049E 02	0.186707729E 00
0.200000000E 02	0.600670350E-02	0.145423040E 02	0.931948276E-01
0.210000000E 02	-0.634300832E-03	0.807379262E 01	0.390892905E-01
0.220000000E 02	0.669395760E-02	0.257475291E 01	-0.130754075E-02
0.230000000E 02	0.821677355E-02	0.343624209E 01	0.941507880E-01
0.240000000E 02	0.450076748E-02	0.583526155E 01	0.137488199E 00
0.250000000E 02	0.132772560E-02	0.755718635E 01	0.142306797E 00
0.260000000E 02	0.633059809E-02	0.510319725E 01	0.142347661E 00
0.270000000E 02	0.195464869E-02	0.223896907E 01	0.651088303E-01
0.280000000E 02	0.211573425E-02	0.477954645E 01	-0.687739965E-01
0.290000000E 02	0.514102713E-02	0.852165197E 01	-0.134383231E 00
0.300000000E 02	0.738570124E-02	0.115893470E 02	-0.872730074E-01

AUTO CORRELATION 1	AUTO CORRELATION 2	CROSS CORRELATION POSITIVE TAU	CROSS CORRELATION NEGATIVE TAU
0.100000000E 01	0.100000000E 01	-0.541683259E-01	-0.541683259E-01
0.958148210E 00	0.305903172E 00	-0.369309294E-01	-0.110887775E 00
0.883842055E 00	-0.146210849E-02	-0.148332711E-02	-0.115300070E 00
0.793895440E 00	-0.339541228E-01	0.889108198E-01	-0.947052437E-01
0.689363387E 00	-0.337419718E-01	0.141123785E 00	-0.940756787E-01
0.578353983E 00	-0.107407122E 00	0.168305611E 00	-0.332007043E-01
0.480029024E 00	0.151061534E-01	0.225758657E 00	-0.209168782E-01
0.398046921E 00	0.205792877E-01	0.344664691E 00	-0.129230518E-01
0.324003383E 00	0.754282785E-01	0.389862631E 00	-0.464779236E-01
0.248944182E 00	0.144686638E 00	0.395037176E 00	-0.420273048E-01
0.179919661E 00	0.113452184E 00	0.388223815E 00	-0.840134531E-01
0.120945413E 00	-0.831602033E-01	0.345327260E 00	-0.131098617E 00
0.896252917E-01	0.321730624E-01	0.307277522E 00	-0.163812881E 00
0.820297496E-01	-0.617812805E-01	0.299762417E 00	-0.210299115E 00
0.826276494E-01	-0.709568306E-02	0.268926077E 00	-0.187933071E 00
0.864895959E-01	-0.265911798E-01	0.269806158E 00	-0.163858319E 00
0.891944276E-01	-0.123640615E 00	0.322138198E 00	-0.181820816E 00
0.652421676E-01	-0.433694696E-01	0.313733961E 00	-0.190901502E 00
0.275680439E-01	0.116999855E 00	0.241485167E 00	-0.170799310E 00
-0.362483811E-01	0.801349254E-01	0.142890954E 00	-0.208330043E 00
-0.115037187E 00	-0.519776075E-01	0.113831388E 00	-0.251219233E 00
-0.189753575E 00	-0.426227771E-01	0.990098465E-01	-0.239165598E 00
-0.281461283E 00	-0.107835827E 00	0.140779155E 00	-0.208045489E 00
-0.390997490E 00	-0.204873650E 00	0.216349067E 00	-0.174485419E 00
-0.503977209E 00	-0.166536696E 00	0.275754361E 00	-0.742622438E-01
-0.595646205E 00	-0.137998844E 00	0.306582519E 00	0.249390119E-01
-0.688914699E 00	-0.856374207E-01	0.269315463E 00	0.690830706E-01
-0.769693787E 00	-0.650444139E-01	0.161809411E 00	0.736416594E-01
-0.804033762E 00	0.193370825E 00	0.123064997E 00	0.113205453E 00
-0.784275542E 00	0.358205367E-01	0.416722235E-01	0.900390921E-01
-0.745554580E 00	-0.111875928E 00	-0.695324894E-01	0.108426676E 00

RAW SPECTRAL ESTIMATES

LAG	POWER SPECTRUM 1	POWER SPECTRUM 2	CO SPECTRA
0.000000000E 00	0.729217490E 00	0.122858678E 00	0.111046107E 01
0.100000000E 01	0.655615579E 01	0.816844366E 00	-0.751108205E-01
0.200000000E 01	-0.140684140E 00	0.431554511E 00	-0.212961289E-01
0.300000000E 01	0.194995734E 01	0.132253102E 00	-0.814271068E 00
0.400000000E 01	0.391804251E 00	0.662364649E 00	-0.283673806E 00
0.500000000E 01	-0.593970951E-01	0.447250030E-01	-0.505940763E-01
0.600000000E 01	0.177516286E 00	0.106595424E 01	-0.332357558E 00
0.700000000E 01	0.634374515E-01	0.730523849E 00	0.450833926E 00
0.800000000E 01	0.162983593E 00	0.323060227E 00	-0.762634855E-01
0.900000000E 01	-0.690900841E-01	0.631757761E 00	-0.673143056E-01
0.100000000E 02	0.436933199E-01	0.243076667E 00	0.144248188E-01
0.110000000E 02	-0.406784999E-01	0.254453627E 00	-0.317491531E-02
0.120000000E 02	0.427214411E-01	0.197474980E 00	-0.909998651E-02
0.130000000E 02	-0.260978995E-01	0.694464983E 00	-0.419873615E-02
0.140000000E 02	0.691562892E-01	0.224814775E 00	0.206398761E-01
0.150000000E 02	-0.265436155E-01	0.278512252E 00	0.273409887E-01
0.160000000E 02	0.368052009E-01	0.128049366E 00	-0.103356914E-01
0.170000000E 02	-0.374539577E-02	0.526194592E 00	0.767070480E-01
0.180000000E 02	0.134846388E-01	-0.297518231E-01	-0.215464354E-01
0.190000000E 02	0.986229494E-02	0.507717543E 00	0.614862552E-01
0.200000000E 02	0.814767191E-02	0.337997120E 00	-0.136795575E-01
0.210000000E 02	-0.955957607E-02	0.234539530E 00	0.251045280E-01
0.220000000E 02	0.122445511E-01	-0.359803537E-01	-0.224133214E-01
0.230000000E 02	0.246684263E-02	0.121856234E 00	0.267537783E-01
0.240000000E 02	0.854547185E-02	0.112785298E 00	0.146324355E-01
0.250000000E 02	-0.796988037E-02	0.229606598E 00	0.192554081E-01
0.260000000E 02	0.144616900E-01	0.146254248E 00	0.233393474E-01
0.270000000E 02	-0.550380073E-02	-0.340364930E-01	0.915188111E-02
0.280000000E 02	0.478367867E-02	0.170115473E 00	-0.676943386E-02
0.290000000E 02	0.111707899E-02	0.139403768E 00	-0.334577033E-01
0.300000000E 02	0.922513571E-02	0.402562030E 00	0.677359548E-02

SMOOTHED SPECTRAL ESTIMATES

LAG	POWER SPECTRUM 1	POWER SPECTRUM 2	CO SPECTRA
0.000000000E 00	0.340960911E 01	0.442092095E 00	0.565097998E 00
0.100000000E 01	0.367568679E 01	0.568610991E 00	0.209948093E 00
0.200000000E 01	0.188043658E 01	0.451331853E 00	-0.216057744E 00
0.300000000E 01	0.111073459E 01	0.323018082E 00	-0.509849461E 00
0.400000000E 01	0.646403151E 00	0.398381874E 00	-0.352102838E 00
0.500000000E 01	0.988692923E-01	0.421664845E 00	-0.169008015E 00
0.600000000E 01	0.967880764E-01	0.753922524E 00	-0.874179158E-01
0.700000000E 01	0.112571196E 00	0.713956205E 00	0.149467480E 00
0.800000000E 01	0.867110348E-01	0.487777292E 00	0.470272305E-01
0.900000000E 01	0.102270446E-01	0.471360676E 00	-0.505726184E-01
0.100000000E 02	-0.165238154E-02	0.335090019E 00	-0.842311868E-02
0.110000000E 02	-0.209099488E-02	0.238731838E 00	-0.489742849E-03
0.120000000E 02	0.771100636E-02	0.324887770E 00	-0.660993255E-02
0.130000000E 02	0.116390122E-01	0.472137735E 00	0.386857084E-03
0.140000000E 02	0.252368477E-01	0.345184743E 00	0.164682512E-01
0.150000000E 02	0.100375903E-01	0.231555369E 00	0.171340964E-01
0.160000000E 02	0.129083359E-01	0.254229232E 00	0.183497750E-01
0.170000000E 02	0.954414941E-02	0.306753514E 00	0.340889167E-01
0.180000000E 02	0.868859176E-02	0.221733806E 00	0.201493846E-01
0.190000000E 02	0.103010707E-01	0.345063891E 00	0.251005995E-01
0.200000000E 02	0.446936817E-02	0.353237572E 00	0.125289191E-01
0.210000000E 02	-0.471959797E-03	0.196115203E 00	0.525508298E-02
0.220000000E 02	0.498072888E-02	0.625416347E-01	-0.175783094E-03
0.230000000E 02	0.611380029E-02	0.834675034E-01	0.126574365E-01
0.240000000E 02	0.334885612E-02	0.141740512E 00	0.184836281E-01
0.250000000E 02	0.987911814E-03	0.183566658E 00	0.191314304E-01
0.260000000E 02	0.471036592E-02	0.123958418E 00	0.191369241E-01
0.270000000E 02	0.145438239E-02	0.543853297E-01	0.875309592E-02
0.280000000E 02	0.157424048E-02	0.116096829E 00	-0.924583339E-02
0.290000000E 02	0.392524996E-02	0.206993861E 00	-0.180662026E-01
0.300000000E 02	0.549542962E-02	0.281509230E 00	-0.117328020E-01