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RANDOM MATRIX DIAGONALIZATION – A COMPUTER PROGRAM

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ABSTRACT

A computer program is described which generates random matrices, diagonalizes them, and sorts appropriately the resulting eigenvalues and eigenvector components. FAP and FORTRAN listings for the IBM 7090 computer are included.

CONTENTS

I. INTRODUCTION

The purpose of this report is to describe a computing machine program which generates random matrices, diagonalizes them, and sorts appropriately the resulting eigenvalues and eigenvector components. Although stochastic matrices are of interest for their own sake, the development of this program has been motivated primarily by problems associated with physical properties of spectra of highly excited many body systems. The various physical applications of the computations will be discussed elsewhere.

II. OUTLINE OF PROGRAM

In this program we are concerned entirely with real symmetric matrices with matrix elements distributed normally about zero mean. (The last paragraph of this section mentions briefly another available input matrix element distribution.) Once the dimension of the matrices is specified, there are only two free parameters A and B in the input; they are the root mean square dispersions of the diagonal and off-diagonal matrix elements. Since only dimensionless variables are studied in the output sorts, only the ratio A/B is important. The choice $A = \sqrt{2}$, $B = 1$ leads to the well-known rotationally invariant Gaussian ensemble of matrices (diagonal matrix element dispersion twice that of the off-diagonal elements).

The input Gaussian distributions for the matrix elements are obtained from a transformation of the random number generator on the library tape. This standard generator provides a sequence of numbers η, distributed such that

$$P(\eta) = \begin{cases} 1 & 0 \leq \eta \leq 1 \\ 0, & \begin{matrix} \eta < 0 \\ \eta > 1 \end{matrix} \end{cases} \quad . \tag{1}$$

By choosing η's in pairs called η_1 and η_2 and making the transformation

$$y_1 = A(-2 \log \eta_1)^{1/2} \cos 2\pi\eta_2 ,$$
$$y_2 = A(-2 \log \eta_1)^{1/2} \sin 2\pi\eta_2 , \qquad (2)$$

one obtains a pair of independent normally distributed variables y_1 and y_2, viz.,

$$P(y_1,y_2) = P(y_1)P(y_2) ,$$

with

$$P(y_1) = (2\pi A^2)^{-1/2} \exp(-y_1^2/2A^2) , \qquad (3)$$

$$P(y_2) = (2\pi A^2)^{-1/2} \exp(-y_2^2/2A^2) .$$

These variables are then fed into the matrix diagonalization subroutine. ($A \rightarrow B$ in (2) gives the off diagonal matrix elements.)

The matrix diagonalization subroutine is a standard package which produces eigenvalues E_i and eigenvector components a_{ij}. The eigenvectors are arranged to be orthonormal, i.e.,

$$\sum_{j=1}^{N} a_{ij}a_{jk} = \delta_{ik} , \qquad (4)$$

where N is the dimension of the matrices. Note that the production of the eigenvector components necessarily involves some arbitrary choices of phases so that the signs of the a_{ij} may not be random. For this reason in the output sorting, only the magnitudes of the components are considered.

Much more output sorting is carried out on the eigenvalues in the present program than on the eigenvector components. The eigenvalues are divided by $2\sqrt{NB^2}$ (a division motivated by the famous semi-circle law of Wigner) and then sorted according to size to obtain the single eigenvalue distribution (which is multiplied by $\pi/2$ to correspond to the semi-circle law). They are ordered and can be sorted individually in order (asymmetric sort) or the counts of highest and lowest, next highest and next lowest, etc. can be combined in pairs as the plus-minus symmetry of the input Gaussians warrant (symmetric sort). The nearest-neighbor, next-nearest-neighbor, etc., spacings are determined and are divided by the mean nearest-neighbor spacing and the resulting numbers are sorted with respect to size to obtain the various spacing distributions and their moments (note that $M_0 = \int_0^\infty P(x)dx$, $M_1 = \int_0^\infty xP(x)dx$, etc.).

The first type of sort puts all N^2 of the a_{ij} in one box (general sort). In addition they are arranged eigenvector by eigenvector to correspond to the ordered eigenvalues and sorted either pairwise (symmetric sort – highest and lowest, next highest and next lowest, etc., together) or singly within each eigenvector (asymmetric sort).

Also included is a random matrix loading routine which loads plus and minus one's in a fixed ratio as a first step to examining the effect of breaking systematically the plus-minus symmetry of the input distribution. This loading replaces that described in (2) and (3); the loading ratio is, however, based on (1) by loading +1 if η is greater than an input parameter A and −1 is η is less than A where $0 \leq A \leq 1$. A then is the loading ratio directly.

III. INPUT DATA

1st Card:

I TAPE : tape to be used for eigenvector components

J TAPE : tape to be used for normalized eigenvalues.

(This tape may be a scratch tape.)

K TAPE : tape to be used for eigenvalues.

2nd Card:

N : dimension of matrix

NM : number of matrices desired

NB : last neighbor relation ($NB < N$)

3rd Card:

WFA : on-diagonal weight factor

WFB : off-diagonal weight factor

4th Card:

DX_i, (i=1,. . .4) : grid width for spacings

5th Card:

DE_i, (i=1,. . .4) : grid width for eigenvalues

6th Card:

DA_i, (i=1,. . .4) : grid width for eigenvector components

7th Card:

Control data:

KONE
- = 0 to suppress all sorting of eigenvalues
- = 1 for general and asymmetric sorting of eigenvalues
- = 2 for general and symmetric sorting of eigenvalues
- = 3 for general sorting of eigenvalues only

KONA $\begin{cases} = 0 \text{ to suppress all sorting of eigenvector components} \\ = 1 \text{ for general and asymmetric sorting of eigenvectors} \\ = 2 \text{ for general and symmetric sorting of eigenvectors} \\ = 3 \text{ for general sorting of eigenvector components only} \end{cases}$

KONN $\begin{cases} = 0 \text{ to sort either eigenvalues or their spacings} \\ \neq 0 \text{ to suppress eigenvalues and their spacings} \end{cases}$

KONX $\begin{cases} = 0 \text{ to compute and sort eigenvalue spacings} \\ \neq 0 \text{ to suppress the spacings} \end{cases}$

8th Card: Restart card,

If the job is not a restart job, this card should be blank.

If it is a restart job, card carries:

W : argument to restart random number generates

M : current matrix index

TOTAL : Sum of nearest neighbor spacings to date.

N. B.

When restarting, change only the last data card.

KEY

E_i (i=1,. . .,N) = Eigenvalues

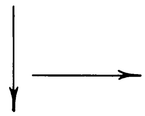
A_i (i=1,. . .,N^2) = Eigenvector components

$U_{i,j}$(j=1,. . .,N; i=1,. . .,N) = Matrix array of the A_i

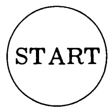
$SPAC_i$ (i=1,. . .,N−1) = Nearest neighbor spacing $= E_{i+1} - E_i$

X_i (i=1,. . .,N-INB) = Normalized spacings, INB is index of neighbor relation.

KEY TO FLOW CHARTS

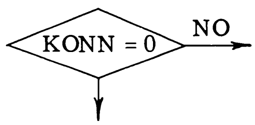


Direction of flow.

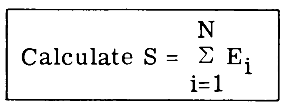


Large circles mark entry and exit points.

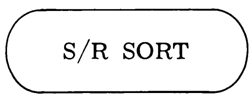
Small circles are connectors or transfer indicators.



Logical decision – to be read: "Is KONN = 0?" If "NO," follow arrow so marked; if "YES," keep going straight.



Executable statement or process.



Transfer to subroutine.

FORMAT FOR DATA CARDS

1ST : 3I2:

2ND : I2,I10,I2:

3RD : 2F10.4:

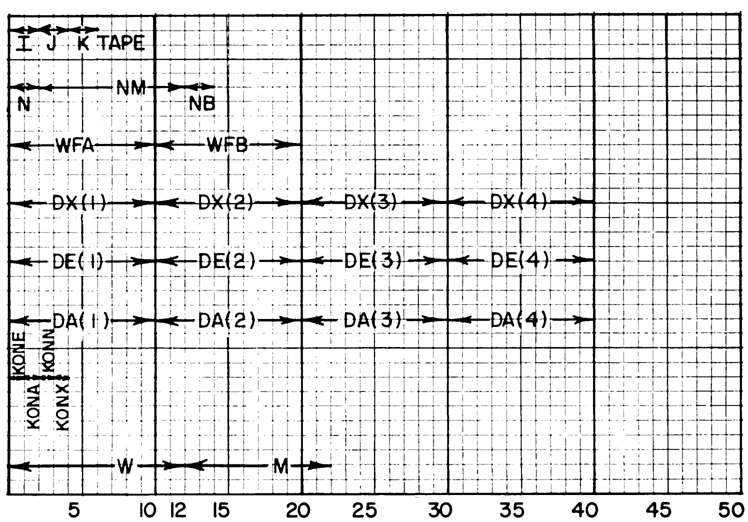
4TH : 4F10.4:

5TH : 4F10.4:

6TH : 4F10.4:

7TH : 4I1:

8TH : ∅12,I10:



N. B.

This program is set up so that after each complete run, it will immediately run again if it encounters another set of eight data cards. Thus the deck may be sent in once to compute short runs with varying combinations of data.

OPERATING INSTRUCTIONS

The program is designed to run under the 709-90 FORTRAN II, Version 2 monitor system.

Three tapes are required; if no restart is envisioned, they may be scratch tapes.

If sense switch 1 is depressed, a restart card is punched and the program discontinued. To restart it, simply mount tapes I and K, replace last data card with the restart card, and execute. As a precaution against lost time in the event of machine failure, a restart card is automatically punched every 20 minutes.

IV. PROGRAM

A. MAIN PROGRAM

The input data is read. Magnetic tapes used are rewound; if performing a restart run, the tapes are positioned as they were when the run was discontinued.

Subroutine MXGEN sets up the matrix, $H_{i,j}$ (i=1,. . .,N; j=1,. . .,N), and calculates the trace, $T = \sum_{i=1}^{N} H_{i,i}$.

Subroutine HDIAG computes the eigenvalues E_i (i=1,. . .N) and the eigenvector components $A_i = U_{j,k}$ (i=1,. . .,N^2; j=1,. . .,N; k=1,. . .,N). The sum of the eigenvalues, $S = \sum_{i=1}^{N} E_i$, is computed and compared with the trace, T. If $S \neq T$, there is an error in the eigenvalues.

The eigenvalues are then ordered ascendingly, after which the eigenvectors are rearranged to match this ordering. The reordered eigenvalues and the absolute values of the components of the reordered eigenvectors are taped for eventual use by the sorting subroutines SPACE, VALUE, VECTOR.

The nearest neighbor spacings of eigenvalues are computed for use in calculating the normalization factor for the spacings.

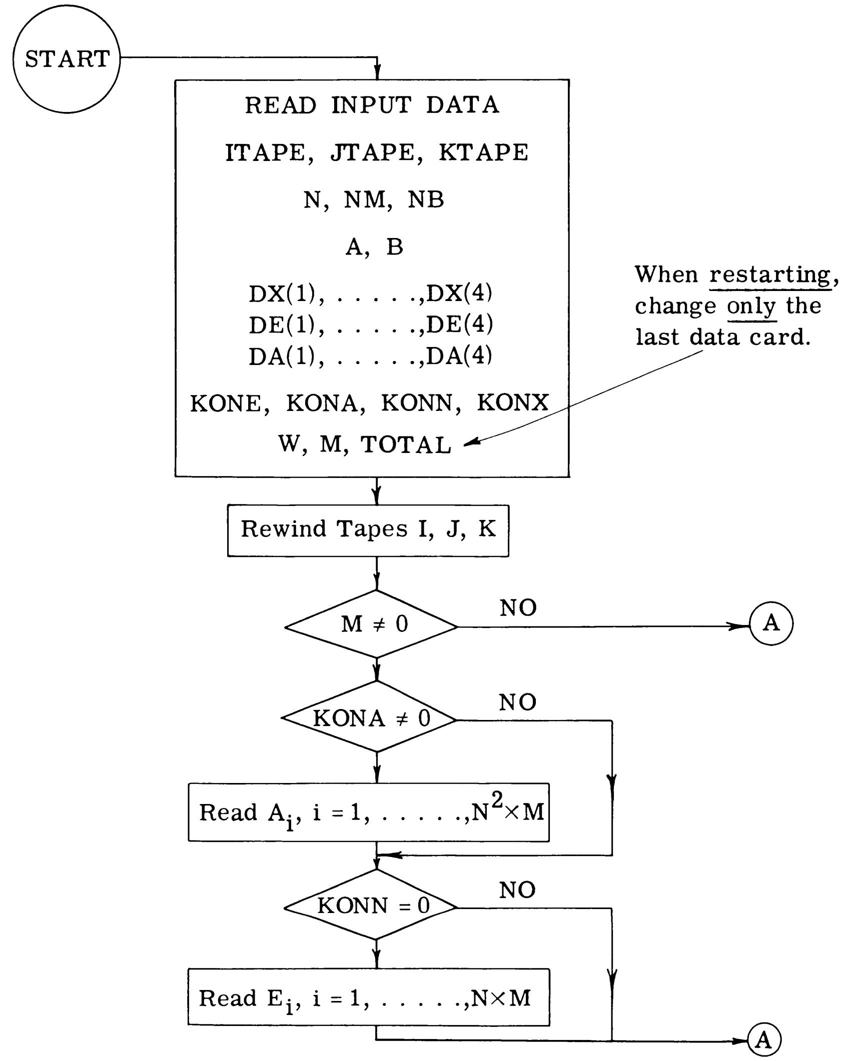
Tests are made whether to punch a restart card or not. This process is repeated for each of NM matrices.

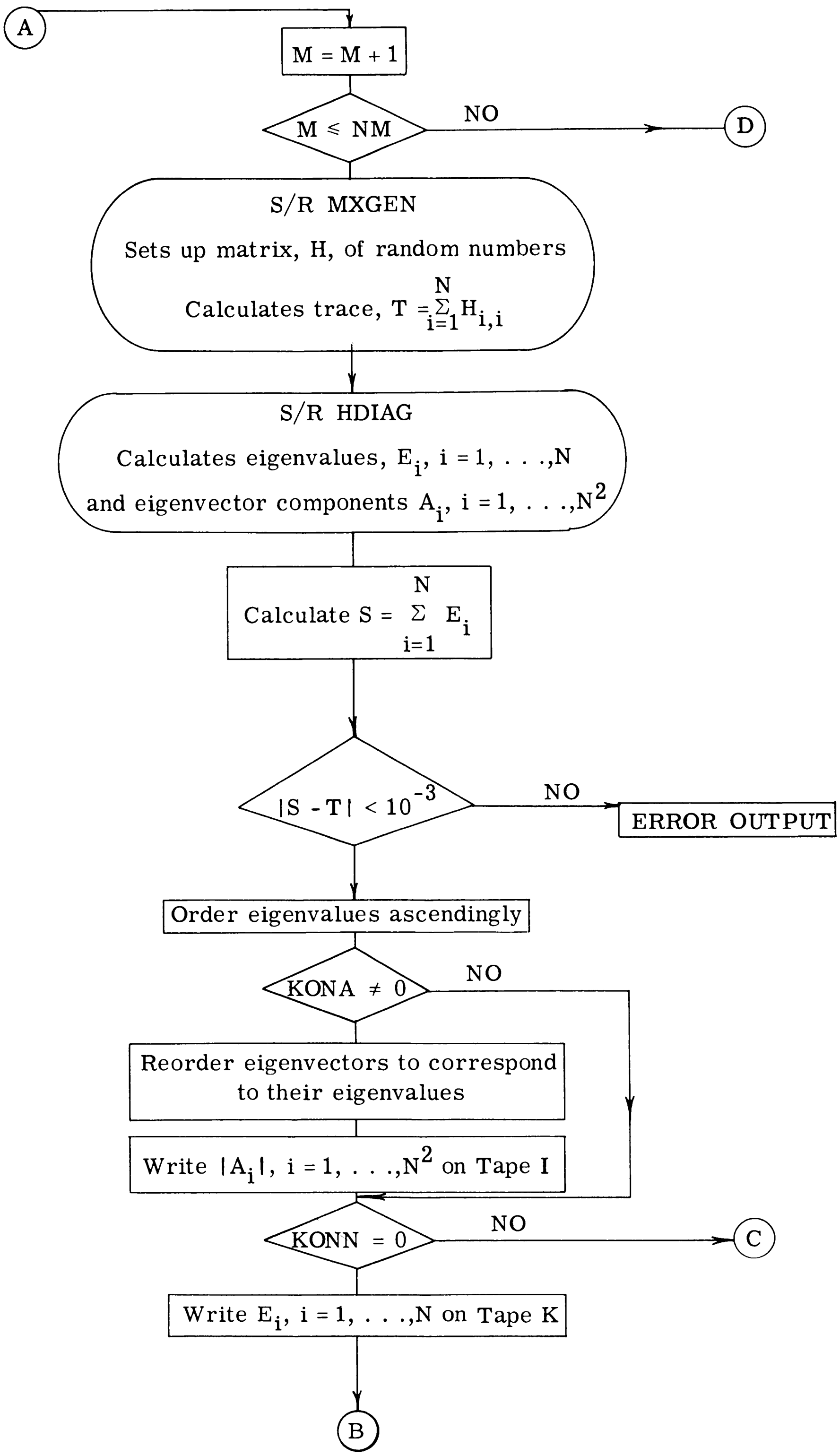
Finally, options are tested for transfer to the subroutines SPACE, VALUE, VECTOR to sort the spacings, eigenvalues, or eigenvector components, respectively.

Provision has been made to repeat this entire process for any desired variations in input data if the program encounters another set of eight data cards.

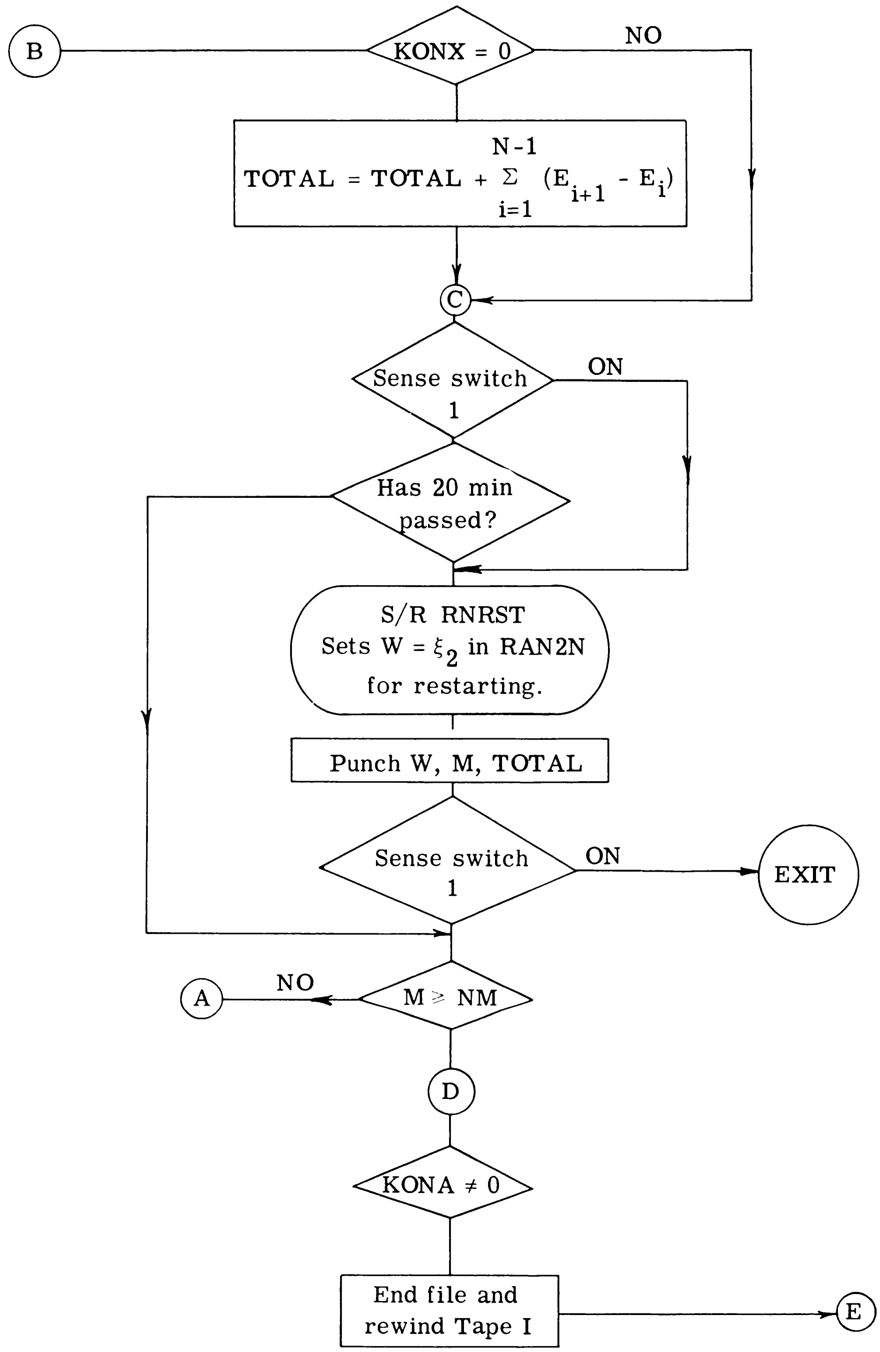
Provision has also been made to stop the program while still diagonalizing the NM matrices and then restart it at the same point without reinitializing the random number generator. This is done by replacing the last data card by a similar card punched by the program containing W, the argument to restart RAN2N or RANUN M, the number of matrices already diagonalized, and TOTAL, the sum of the nearest neighbor spacings. Such a card is punched after every 20 min of diagonalization. (This feature can only be used on a 7090 equipped with a core clock.) If sense switch 1 is turned on, a restart card is punched, and the program exits: control returns to the monitor.

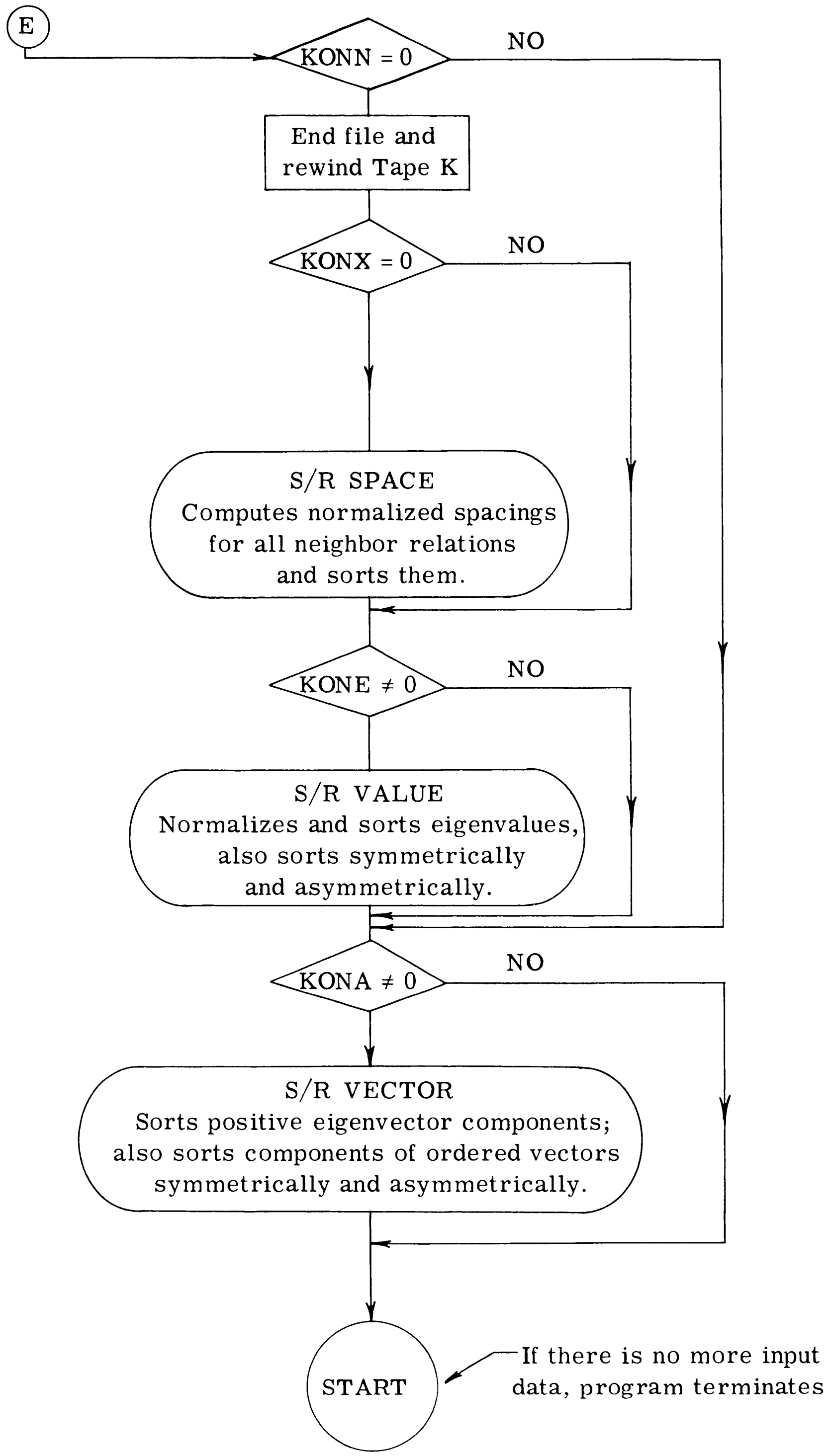
RANDOM MATRIX DIAGONALIZATION
MAIN PROGRAM





A
M = M + 1
M ≤ NM
NO
D
S/R MXGEN
Sets up matrix, H, of random numbers
Calculates trace, $T = \sum_{i=1}^{N} H_{i,i}$
S/R HDIAG
Calculates eigenvalues, E_i, i = 1, . . .,N
and eigenvector components A_i, i = 1, . . .,N^2
Calculate $S = \sum_{i=1}^{N} E_i$
$|S - T| < 10^{-3}$
NO
ERROR OUTPUT
Order eigenvalues ascendingly
KONA ≠ 0
NO
Reorder eigenvectors to correspond to their eigenvalues
Write $|A_i|$, i = 1, . . .,N^2 on Tape I
KONN = 0
NO
C
Write E_i, i = 1, . . .,N on Tape K
B


B
KONX = 0
NO
TOTAL = TOTAL + $\sum_{i=1}^{N-1} (E_{i+1} - E_i)$
C
Sense switch 1
ON
Has 20 min passed?
S/R RNRST
Sets W = ξ_2 in RAN2N
for restarting.
Punch W, M, TOTAL
Sense switch 1
ON
EXIT
A
NO
M ≥ NM
D
KONA ≠ 0
End file and rewind Tape I
E


E
KONN = 0
NO
End file and rewind Tape K
KONX = 0
NO
S/R SPACE
Computes normalized spacings for all neighbor relations and sorts them.
KONE ≠ 0
NO
S/R VALUE
Normalizes and sorts eigenvalues, also sorts symmetrically and asymmetrically.
KONA ≠ 0
NO
S/R VECTOR
Sorts positive eigenvector components; also sorts components of ordered vectors symmetrically and asymmetrically.
START
If there is no more input data, program terminates.

RMD   RANDØM MATRIX DIAGØNALIZATIØN

```
      DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)
     1          ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)
      CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,
     1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,
     2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM
C
C
C     ITAPE  IS USED FØR THE EIGENVECTØR CØMPØNENTS
C     JTAPE  IS USED FØR THE NØRMALIZED EIGENVALUES
C     KTAPE  IS USED FØR THE EIGENVALUES
C
   10 READINPUTTAPE5,20,ITAPE,JTAPE,KTAPE
   20 FØRMAT(3I2)
C
C     N    IS DIMENSIØN ØF MATRIX
C     NM   IS THE NUMBER ØF MATRICES DESIRED
C     NB   IS LAST NEIGHBØR RELATIØN      (N-1)
C
      READINPUTTAPE5,30,N,NM,NB
   30 FØRMAT(I2,I10,I2)
C
C     WFA  IS ØN-DIAGØNAL WEIGHTING FACTØR
C     WFB  IS ØFF-DIAGØNAL WEIGHTING FACTØR
C
      READINPUTTAPE5,40,WFA,WFB
   40 FØRMAT(2F10.4)
C
C     DX   IS GRID WIDTH FØR SPACINGS
C     DE   IS GRID WIDTH FØR EIGENVALUES
C     DA   IS GRID WIDTH FØR EIGENVECTØR CØMPØNENTS
C
      READINPUTTAPE5,50,(DX(I),I=1,4)
      READINPUTTAPE5,50,(DE(I),I=1,4)
      READINPUTTAPE5,50,(DA(I),I=1,4)
   50 FØRMAT(4F10.4)
C
C     KØNE   EQUALS 0 TØ SUPPRESS ALL SØRTING ØF EIGENVALUES
C            EQUALS 1 FØR GENERAL AND ASYMMETRIC SØRTING ØF EIGENVALUES
C            EQUALS 2 FØR GENERAL AND SYMMETRIC SØRTING ØF EIGENVALUES
C            EQUALS 3 FØR JUST GENERAL SØRTING ØF EIGENVALUES
C     KØNA   EQUALS 0 TØ SUPPRESS ALL SØRTING ØF EIGENVECTØR CØMPØNENTS
C            EQUALS 1 FØR GENERAL AND ASYMMETRIC SØRTING ØF EIGENVECTØRS
C            EQUALS 2 FØR GENERAL AND SYMMETRIC SØRTING ØF EIGENVECTØRS
C            EQUALS 3 FØR JUST GENERAL SØRTING ØF EIGNEVECTØR CØMPØNENTS
C     KØNN   EQUALS 0 TØ SØRT EITHER EIGENVALUES ØR THEIR SPACINGS
C            IS UNEQUAL TØ 0 TØ SUPPRESS EIGENVALUES AND THEIR SPACINGS
C     KØNX   EQUALS 0 TØ CØMPUTE AND SØRT EIGENVALUE SPACINGS
C            IS UNEQUAL TØ 0 TØ SUPPRESS THE SPACINGS
C
      READINPUTTAPE5,60,KØNE,KØNA,KØNN,KØNX
   60 FØRMAT(4I1)
C
C     W        IS RESET ARGUMENT FØR REENTRY INTØ GENERATING SUBRØUTINE
C     M        IS MATRIX INDEX
C     TØTAL    SUM ØF NEAREST NEIGHBØR SPACINGS FØR NØRMALIZATIØN FACTØR
```

```
C           INITIALIZE AS A BLANK CARD
C           TØ RESTART, USE CARD PUNCHED IN LAST RUNNING ØF PRØGRAM
C
      READINPUTTAPE5,70,W,M,TØTAL
   70 FØRMAT(Ø12,I10,Ø15)
C
C     PRINT HEADINGS
C
   80 CALLDATE(DAY)
      WRITEØUTPUTTAPE6,90,DAY
   90 FØRMAT(1H1/1H345X30H RANDØM MATRIX DIAGØNALIZATIØN////49X15H PERFØ
     1RMED ØN  2A6////)
      WRITEØUTPUTTAPE6,100,N,WFA,WFB
  100 FØRMAT(49XI2,21H - DIMENSIØNAL MATRIX////39X6H WFA =1PE14.7,
     1 10H     WFB =1PE14.7////)
      WRITEØUTPUTTAPE6,110
  110 FØRMAT(1H1/1H454X11H INPUT DATA///)
      WRITEØUTPUTTAPE6,120,ITAPE,JTAPE,KTAPE
  120 FØRMAT(38X8H ITAPE =I3,5X8H JTAPE =I3,5X8H KTAPE =I3//)
      WRITEØUTPUTTAPE6,130,N,NM,NB
  130 FØRMAT(39X4H N =I3,5X5H NM =I11,5X5H NB =I3//)
      WRITEØUTPUTTAPE6,140,WFA,WFB
  140 FØRMAT(40X7H WFA = F10.4,5X7H WFB = F10.4//)
      WRITEØUTPUTTAPE6,150,(DX(I),I=1,4)
  150 FØRMAT(33X7H DX ARE4F10.4//)
      WRITEØUTPUTTAPE6,160,(DE(I),I=1,4)
  160 FØRMAT(33X7H DE ARE4F10.4//)
      WRITEØUTPUTTAPE6,170,(DA(I),I=1,4)
  170 FØRMAT(33X7H DA ARE4F10.4//)
      WRITEØUTPUTTAPE6,180,KØNE,KØNA,KØNN,KØNX
  180 FØRMAT(34X7H KØNE =I2,9H   KØNA =I2,9H   KØNN =I2,9H   KØNX =I2//)
      WRITEØUTPUTTAPE6,190,W,M,TØTAL
  190 FØRMAT(41X5H W = Ø12,5X4H M =I11//50X8HTØTAL = Ø12///)
C
      KN=1
      KE=M
      NS=N*N
      NT=N-1
      FNM=NM
      REWINDITAPE
      REWINDJTAPE
      REWINDKTAPE
      CALLRCLØK
      IF(M)200,280,200
  200 IF(KØNA)210,230,210
  210 DØ220I=1,M
  220 READTAPEITAPE,(A(L),L=1,NS)
  230 IF(KØNN)280,240,280
  240 DØ250I=1,M
  250 READTAPEKTAPE,(E(I),I=1,N)
      KE=KE+1
  280 M=M+1
      IF(M-NM)290,290,610
C
C     PRØDUCE RANDØM NUMBER MATRIX
C
```

```
  290 CALLMXGEN(W)
C
C      DIAGØNALIZE AND PRØDUCE EIGENVALUES
C
  300 CALLHDIAG(0,NR)
      S=0.
  310 DØ320I=1,N
      E(I)=H(I,I)
  320 S=S+E(I)
C
C      CHECK AND ERRØR PRINT
C
  330 IF(ABSF(S-T)-0.001)440,440,340
  340 WRITEØUTPUTTAPE6,350,KN,M
  350 FØRMAT(19H0          S-T ERRØR,I3,10H ØN MATRIX,I3//)
      WRITEØUTPUTTAPE6,360,S,T
  360 FØRMAT(10X,4H S =,E11.4,8H      T =,E11.4//)
      WRITEØUTPUTTAPE6,370,(E(I),I=1,N)
  370 FØRMAT(10X,12H EIGENVALUES/(10X,7E15.4//))
      WRITEØUTPUTTAPE6,380,(HD(I),I=1,N)
  380 FØRMAT(10X,27H ØRIGINAL DIAGØNAL ELEMENTS/(10X,7E15.4//))
      WRITEØUTPUTTAPE6,390
  390 FØRMAT(10X,7H MATRIX)
      DØ400I=1,N
  400 WRITEØUTPUTTAPE6,410,(H(I,J),J=1,N)
  410 FØRMAT(1H08E15.4/(8E15.4))
      IF(KN-5)430,420,420
  420 CALLDUMP
  430 KN=KN+1
C
C      ØRDER EIGENVALUES
C
  440 DØ450K=1,N
  450 IGRID(K)=K
      DØ470L=1,NT
      LJ=L+1
      DØ470J=LJ,N
      IF(E(L)-E(J))470,470,460
  460 TEMP=E(L)
      E(L)=E(J)
      E(J)=TEMP
      INTER=IGRID(L)
      IGRID(L)=IGRID(J)
      IGRID(J)=INTER
  470 CØNTINUE
C
C      PRØDUCE EIGENVECTØR CØMPØNENTS BY VECTØRS CØRRESPØNDING TØ
C               THE ØRDERED EIGENVALUES
C
      IF(KØNA)480,500,480
  480 KA=0
      DØ490L=1,N
      LT=IGRID(L)
      DØ490K=1,N
      KA=KA+1
  490 A(KA)=ABSF(U(K,LT))
```

```
      WRITETAPEITAPE,(A(I),I=1,NS)                                      RMD00168
C                                                                       RMD00169
  500 IF(KØNN)540,510,540                                               RMD00170
  510 WRITETAPEKTAPE,(E(L),L=1,N)                                       RMD00171
C                                                                       RMD00172
C     CØMPUTE FIRST SPACINGS FØR NØRMALIZATIØN FACTØR                   RMD00173
C                                                                       RMD00174
      IF(KØNX)540,520,540                                               RMD00175
  520 DØ530I=1,NT                                                       RMD00176
  530 TØTAL=TØTAL+E(I+1)-E(I)                                           RMD00177
  540 IF(SENSESWITCH1)570,550                                           RMD00178
  550 CALLICLØK(ITIME)                                                  RMD00179
  560 IF(72000-ITIME)570,570,600                                        RMD00180
  570 CALLRNRST(W)                                                      RMD00181
      PUNCH580,W,M,TØTAL,DAY(1)                                         RMD00182
  580 FØRMAT(Ø12,I10,Ø15,35XA5,3HRMD)                                   RMD00183
      WRITEØUTPUTTAPE6,70,W,M,TØTAL                                     RMD00184
      CALLRCLØK                                                         RMD00185
      IF(SENSESWITCH1)590,600                                           RMD00186
  590 REWINDITAPE                                                       RMD00187
      REWINDKTAPE                                                       RMD00188
      CALLEXIT                                                          RMD00189
  600 IF(M-NM)280,610,610                                               RMD00190
  610 N2=N/2                                                            RMD00191
      N21=N2+1                                                          RMD00192
      IF(KØNA)620,630,620                                               RMD00193
  620 ENDFILEITAPE                                                      RMD00194
      REWINDITAPE                                                       RMD00195
  630 IF(KØNN)680,640,680                                               RMD00196
  640 ENDFILEKTAPE                                                      RMD00197
      REWINDKTAPE                                                       RMD00198
C                                                                       RMD00199
C     TEST ØPTIØNS FØR SØRTINGS                                         RMD00200
C                                                                       RMD00201
      IF(KØNX)660,650,660                                               RMD00202
  650 CALLSPACE                                                         RMD00203
  660 IF(KØNE)670,680,670                                               RMD00204
  670 CALLVALUE                                                         RMD00205
  680 IF(KØNA)690,700,690                                               RMD00206
  690 CALLVECTØR                                                        RMD00207
  700 WRITEØUTPUTTAPE6,710                                              RMD00208
  710 FØRMAT(1H1)                                                       RMD00209
      IFACCUMULATØRØVERFLØW720,740                                      RMD00210
  720 WRITEØUTPUTTAPE6,730                                              RMD00211
  730 FØRMAT(21H3ACCUMULATØR ØVERFLØW)                                  RMD00212
  740 IFDIVIDECHECK750,10                                               RMD00213
  750 WRITEØUTPUTTAPE6,760                                              RMD00214
  760 FØRMAT(13H3DIVIDE CHECK)                                          RMD00215
      GØ TØ 10                                                          RMD00216
      END
```

A1. SUBROUTINE MXGEN

Calling sequence: CALL MXGEN (W)

W = ξ_2 in RAN2N and RANUN – argument to restart the generating sequence of random numbers.

This routine was separated from the main program to facilitate changing the type of matrix used. Thus there are two routines called by the same calling sequence, but with differently labeled binary decks and listings:

MXNORM – Uses RAN2N to generate $\frac{1}{2}(N^2 + N)$ normally distributed random numbers. These numbers are then used to set up an $N \times N$ real symmetric matrix, H. The random numbers used for the diagonal elements are multiplied by WFA; those for the off-diagonal elements, by WFB.

MXONES – Uses RANUN to generate $\frac{1}{2}(N^2+N)$ random numbers, η, uniformly distributed between 0 and 1. The matrix H is then loaded with plus or minus ones depending on whether η is, respectively, greater or less than an arbitrary parameter, WFA, with $H_{ij} = H_{ji}$.

Both routines compute the trace, $T = \sum_{i=1}^{N} H_{i,i}$. Both use RNSET to restart the generating subroutine.

MXNØRM

```
C      RØUTINE TØ GENERATE RANDØM NUMBER MATRICES
C
C      CALLING SEQUENCE IS
C               CALL MXGEN(W)
C
C      W  IS ARGUMENT FØR REENTRY INTØ RANDØM NUMBER GENERATØR
C
       SUBRØUTINEMXGEN(W)
C
       DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)
      1          ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)
       CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,
      1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,
      2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM
C
C      GENERATE (N**2+N)/2 NØRMALLY DISTRIBUTED RANDØM NUMBERS
C
       LD=(N**2+N)/2
       IF(M-KE)20,10,20
    10 CALLRNSET(W)
    20 DØ30I=1,LD,2
       CALLRAN2N(Y1,Y2)
       BL(I)=Y1
    30 BL(I+1)=Y2
C
C      SET UP MATRIX AND CØMPUTE TRACE
C
       T=0.
       L=1
       DØ60I=1,N
       DØ60J=I,N
       IF(I-J)50,40,50
    40 H(I,I)=BL(L)*WFA
       HD(I)=H(I,I)
       T=T+HD(I)
       GØTØ60
    50 H(I,J)=BL(L)*WFB
       H(J,I)=H(I,J)
    60 L=L+1
       RETURN
       END
```

MXØNES

```
C      RØUTINE TØ GENERATE RANDØM NUMBER MATRICES                        MXØNES01
C                                                                        MXØNES02
C      CALLING SEQUENCE IS                                               MXØNES03
C                CALL MXGEN(W)                                           MXØNES04
C                                                                        MXØNES05
C      W  IS ARGUMENT FØR REENTRY INTØ RANDØM NUMBER GENERATØR           MXØNES06
C                                                                        MXØNES07
       SUBRØUTINEMXGEN(W)                                                MXØNES08
C                                                                        MXØNES09
       DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)MXØNES10
      1          ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)MXØNES11
       CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,     MXØNES12
      1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,   MXØNES13
      2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM                 MXØNES14
C                                                                        MXØNES15
C      GENERATE (N**2+N)/2 RANDØM NUMBERS UNIFØRMLY DISTRIBUTED          MXØNES16
C                BETWEEN 0 AND 1                                         MXØNES17
C                                                                        MXØNES18
       T=C.                                                              MXØNES19
       IF(M-KE)20,10,20                                                  MXØNES20
   10 CALLRNSET(W)                                                       MXØNES21
   20 DØ80I=1,N                                                          MXØNES22
       SENSELIGHT3                                                       MXØNES23
       DØ80J=I,N                                                         MXØNES24
       CALLRANUN(ETA)                                                    MXØNES25
C                                                                        MXØNES26
C      SET UP WEIGHTED MATRIX ØF PLUS AND MINUS ØNES AND CØMPUTE TRACE   MXØNES27
C                                                                        MXØNES28
       IF(ETA-WFA)30,30,40                                               MXØNES29
   30 ETA=-1.                                                            MXØNES30
       GØ TØ 50                                                          MXØNES31
   40 ETA=+1.                                                            MXØNES32
   50 H(I,J)=ETA                                                         MXØNES33
       IF(SENSELIGHT3)60,70                                              MXØNES34
   60 T=T+H(I,I)                                                         MXØNES35
   70 H(J,I)=H(I,J)                                                      MXØNES36
   80 CØNTINUE                                                           MXØNES37
       RETURN                                                            MXØNES38
       END
```

A2. SUBROUTINE RAN2N

Calling sequence:

CALL RAN2N (Y1, Y2) — Produces two normally distributed random numbers of mean zero and standard deviation one:

$$Y1 = \sqrt{-2 \ln \eta_1} \cos 2\pi\eta_2$$

$$Y2 = \sqrt{-2 \ln \eta_1} \sin 2\pi\eta_2$$

η_1, η_2 are random numbers uniformly distributed on (0,1), produced as follows:

two constants, ξ_1, ξ_2 are multiplied together. The low order bits of the product replace ξ_2, and are converted to a normalized, floating point number between 0 and 1. η_2 is generated in the same way, using the new ξ_2.

Provision has been made to record the variable factor ξ_2 and to restart the sequence of random numbers at any point:

CALL RANUN (ETA) — Produces a uniformly distributed random number, η, such that $0 < \eta < 1$.

CALL RNRST (W) — sets $W = \xi_2$

CALL RNSET (X) — sets $\xi_2 = X$, if $X \neq 0$; if $X = 0$, ξ_2 is restored to its value at load time.

```
RAN2N          GENERATES 2 NØRMALLY DISTRIBUTED RANDØM NUMBERS

                       00006          ENTRY    RAN2N                            RAN2N003
                       00075          ENTRY    RANUN                            RAN2N004
                       00064          ENTRY    RNSET                            RAN2N005
                       00072          ENTRY    RNRST                            RAN2N006

00000   434627606060       LØG
00001   625051636060       SQRT
00002   234662606060       CØS
00003   623145606060       SIN

00006   0634 00 4 00051   RAN2N SXA    BK,4                                     RAN2N007
00007   0560 00 0 00057         LDQ    RA                                       RAN2N008
00010   0200 00 0 00060         MPY    RB                                       RAN2N009
00011   0763 00 0 00005         LLS    5                                        RAN2N010
00012 -0754 00 0 00000          ZAC                                             RAN2N011
00013   0765 00 0 00005         LRS    5                                        RAN2N012
00014 -0600 00 0 00057          STQ    RA                                       RAN2N013
00015   0763 00 0 00040         LLS    32                                       RAN2N014
00016 -0501 00 0 00056          ØRA    CH                                       RAN2N015
00017   0300 00 0 00056         FAD    CH                                       RAN2N016
00020   0074 00 4 00000         TSX    $LØG,4                                   RAN2N017
00021   0131 00 0 00000         XCA                                             RAN2N018
00022   0260 00 0 00112         FMP    =-2.                                     RAN2N019
00023   0074 00 4 00001         TSX    $SQRT,4                                  RAN2N020
00024   0601 00 0 00061         STØ    WS1                                      RAN2N021
00025   0560 00 0 00057         LDQ    RA                                       RAN2N022
00026   0200 00 0 00060         MPY    RB                                       RAN2N023
00027   0763 00 0 00005         LLS    5                                        RAN2N024
00030 -0754 00 0 00000          ZAC                                             RAN2N025
00031   0765 00 0 00005         LRS    5                                        RAN2N026
00032 -0600 00 0 00057          STQ    RA                                       RAN2N027
00033   0763 00 0 00040         LLS    32                                       RAN2N028
00034 -0501 00 0 00056          ØRA    CH                                       RAN2N029
00035   0300 00 0 00056         FAD    CH                                       RAN2N030
00036   0131 00 0 00000         XCA                                             RAN2N031
00037   0260 00 0 00111         FMP    =6.2831853                               RAN2N032
00040   0601 00 0 00062         STØ    WS2                                      RAN2N033
00041   0074 00 4 00002         TSX    $CØS,4                                   RAN2N034
00042   0131 00 0 00000         XCA                                             RAN2N035
00043   0260 00 0 00061         FMP    WS1                                      RAN2N036
00044   0601 00 0 00063         STØ    WS3                                      RAN2N037
00045   0500 00 0 00062         CLA    WS2                                      RAN2N038
00046   0074 00 4 00003         TSX    $SIN,4                                   RAN2N039
00047   0131 00 0 00000         XCA                                             RAN2N040
00050   0260 00 0 00061         FMP    WS1                                      RAN2N041
00051   0774 00 4 00000   BK    AXT    **,4                                     RAN2N042
00052   0601 60 4 00002         STØ*   2,4                                      RAN2N043
00053   0500 00 0 00063         CLA    WS3                                      RAN2N044
00054   0601 60 4 00001         STØ*   1,4                                      RAN2N045
00055   0020 00 4 00003         TRA    3,4                                      RAN2N046
00056   2 00000 0 00000   CH    TWØ    0                                        RAN2N047
00057 +005343277245       RA    ØCT    005343277245                             RAN2N048
00060 +005343277245       RB    ØCT    005343277245                             RAN2N049
00061   0 00000 0 00000   WS1   PZE    0                                        RAN2N050
00062   0 00000 0 00000   WS2   PZE    0                                        RAN2N051
```

```
00063  0 00000 0 00000   WS3   PZE    0                          RAN2N052
00064  0500 60 4 00001   RNSET CLA*   1,4                        RAN2N053
00065 -0320 00 0 00110         ANA    =Ø7777777777               RAN2N054
00066 -0100 00 0 00070         TNZ    *+2                        RAN2N055
00067  0500 00 0 00060         CLA    RB                         RAN2N056
00070  0601 00 0 00057         STØ    RA                         RAN2N057
00071  0020 00 4 00002         TRA    2,4                        RAN2N058
00072  0500 00 0 00057   RNRST CLA    RA                         RAN2N059
00073  0601 60 4 00001         STØ*   1,4                        RAN2N060
00074  0020 00 4 00002         TRA    2,4                        RAN2N061
00075  0560 00 0 00057   RANUN LDQ    RA                         RAN2N062
00076  0200 00 0 00060         MPY    RB                         RAN2N063
00077  0763 00 0 00005         LLS    5                          RAN2N064
00100 -0754 00 0 00000         ZAC                               RAN2N065
00101  0765 00 0 00005         LRS    5                          RAN2N066
00102 -0600 00 0 00057         STQ    RA                         RAN2N067
00103  0763 00 0 00040         LLS    32                         RAN2N068
00104 -0501 00 0 00056         ØRA    CH                         RAN2N069
00105  0300 00 0 00056         FAD    CH                         RAN2N070
00106  0601 60 4 00001         STØ*   1,4                        RAN2N071
00107  0020 00 4 00002         TRA    2,4                        RAN2N072
                               END                               RAN2N073
```

A3. SUBROUTINE HDIAG

Calling sequence: CALL HDIAG (IEGEN, NR)

IEGEN is set unequal to zero if only eigenvalues are to be computed;

is set equal to zero if eigenvalues and eigenvectors are to be computed.

NR is the number of rotations.

In addition, HDIAG expects to find the following arguments in COMMON:

H : the matrix to be diagonalized. Only the elements to the right of the main diagonal are operated on; at exit the eigenvalues are along the diagonal of H;

U : will contain the eigenvectors stored columnwise;

N : the order of the matrix H.

This subroutine is an adaptation of MI HDI3 by M. Merwin, distributed through SHARE. The Jacobi method is used.

HDIAG   DIAGØNALIZATIØN ØF REAL SYMMETRIC MATRIX

```
      SUBRØUTINEHDIAG(IEGEN,NR)
      DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)
     1    ,IQ(50),E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)
      CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,
     1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,
     2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM
C
      IF (IEGEN) 15,10,15
 10   DØ 14 I=1,N
      DØ 14 J=1,N
      IF(I-J)12,11,12
 11   U(I,J)=1.0
      GØ TØ 14
 12   U(I,J)=0.
 14   CØNTINUE
C
 15   NR = 0
      IF (N-1) 1000,1000,17
C
C     SCAN FØR LARGEST ØFF DIAGØNAL ELEMENT IN EACH RØW
C     X(I) CØNTAINS LARGEST ELEMENT IN ITH RØW
C     IQ(I) HØLDS SECØND SUBSCRIPT DEFINING PØSITIØN ØF ELEMENT
C
 17   NMI1=N-1
      DØ 30 I=1,NMI1
      X(I) = 0.
      IPL1=I+1
      DØ 30 J=IPL1,N
      IF ( X(I) - ABSF( H(I,J))) 20,20,30
 20   X(I)=ABSF(H(I,J))
      IQ(I)=J
 30   CØNTINUE
C
C     SET INDICATØR FØR SHUT-ØFF.RAP=2**-27,NR=NØ. ØF RØTATIØNS
      RAP=7.450580596E-9
      HDTEST=1.0E38
C
C     FIND MAXIMUM ØF X(I) S FØR PIVØT ELEMENT AND
C     TEST FØR END ØF PRØBLEM
C
 40   DØ  70  I=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   CØNTINUE
C
C     IS MAX. X(I) EQUAL TØ ZERØ, IF LESS THAN HDTEST, REVISE HDTEST
      IF ( XMAX) 1000,1000,80
 80   IF (HDTEST) 90,90,85
 85   IF (XMAX - HDTEST) 90,90,148
 90   HDIMIN = ABSF( H(1,1) )
      DØ 110  I= 2,N
      IF (HDIMIN- ABSF( H(I,I))) 110,110,100
```

```
 100   HDIMIN=ABSF(H(I,I))
 110   CØNTINUE
C
       HDTEST=HDIMIN*RAP
C
C      RETURN IF MAX.H(I,J)LESS THAN(2**-27)ABSF(H(K,K)-MIN)
       IF (HDTEST- XMAX) 148,1000,1000
 148   NR = NR+1
C
C      CØMPUTE TANGENT, SINE AND CØSINE,H(I,I),H(J,J)
 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))
       CØSINE=1.0/SQRTF(1.0+TANG**2)
       SINE=TANG*CØSINE
       HII=H(IPIV,IPIV)
       H(IPIV,IPIV)=CØSINE**2*(HII+TANG*(2.*H(IPIV,JPIV)+TANG*H(JPIV,JPIV
      1)))
       H(JPIV,JPIV)=CØSINE**2*(H(JPIV,JPIV)-TANG*(2.*H(IPIV,JPIV)-TANG*H
      1II))
       H(IPIV,JPIV)=0.
C
C       PSEUDØ RANK THE EIGENVALUES
C       ADJUST SINE AND CØS FØR CØMPUTATIØN ØF H(IK) AND U(IK)
       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
C        RECØMPUTE SINE AND CØS
       HTEMP = SIGNF (1.0, -SINE) * CØSINE
       CØSINE = ABSF (SINE)
       SINE = HTEMP
 153   CØNTINUE
C
C      INSPECT THE IQS BETWEEN I+1 AND N-1 TØ DETERMINE
C      WHETHER A NEW MAXIMUM VALUE SHØULD BE CØMPUTED SINCE
C      THE PRESENT MAXIMUM IS IN THE I ØR J RØW.
C
       DØ 350 I=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.
C
C      SEARCH IN DEPLETED RØW FØR NEW MAXIMUM
C
       DØ 320 J=IPL1,N
       IF ( X(I)- ABSF( H(I,J)) ) 300,300,320
 300   X(I) = ABSF(H(I,J))
       IQ(I)=J
 320   CØNTINUE
```

```
      H(I,K)=HTEMP
 350  CØNTINUE
C
      X(IPIV) =0.
      X(JPIV) =0.
C
C     CHANGE THE ØTHER ELEMENTS ØF H
C
      DØ 530 I=1,N
C
      IF(I-IPIV)370,530,420
 370  HTEMP = H(I,IPIV)
      H(I,IPIV) = CØSINE*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 + CØSINE*H(I,JPIV)
      IF ( X(I) -  ABSF( H(I,JPIV)) ) 400,530,530
 400  X(I) = ABSF(H(I,JPIV))
      IQ(I) = JPIV
      GØ TØ 530
C
 420  IF(I-JPIV)430,530,480
 430  HTEMP = H(IPIV,I)
      H(IPIV,I) = CØSINE*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 + CØSINE*H(I,JPIV)
      IF ( X(I) -  ABSF( H(I,JPIV)) ) 400,530,530
C
 480  HTEMP = H(IPIV,I)
      H(IPIV,I) = CØSINE*HTEMP + SINE*H(JPIV,I)
      IF ( X(IPIV) -  ABSF( H(IPIV,I)) ) 490,500,500
 490  X(IPIV) = ABSF(H(IPIV,I))
      IQ(IPIV) = I
 500  H(JPIV,I) = -SINE*HTEMP + CØSINE*H(JPIV,I)
      IF ( X(JPIV) -  ABSF( H(JPIV,I)) ) 510,530,530
 510  X(JPIV) = ABSF(H(JPIV,I))
      IQ(JPIV) = I
 530  CØNTINUE
C
C     TEST FØR CØMPUTATIØN ØF EIGENVECTØRS
C
      IF(IEGEN)40,540,40
 540  DØ 550 I=1,N
      HTEMP=U(I,IPIV)
      U(I,IPIV)=CØSINE*HTEMP+SINE*U(I,JPIV)
 550  U(I,JPIV)=-SINE*HTEMP+CØSINE*U(I,JPIV)
      GØ TØ 40
 1000 RETURN
      END
```

B. SUBROUTINE SPACE

Calling sequence: CALL SPACE

1. Calculates the normalization factor, $D = \left(\sum_{m=1}^{NM} \sum_{i=1}^{N-1} SPAC_{i,m}\right)/[NM*(N-1)]$, where $SPAC_{i,m}$ are the nearest neighbor spacings of eigenvalues, E_i (i=1, . . .,N), for the m^{th} matrix, NM the number of matrices, N the dimension of the matrices.

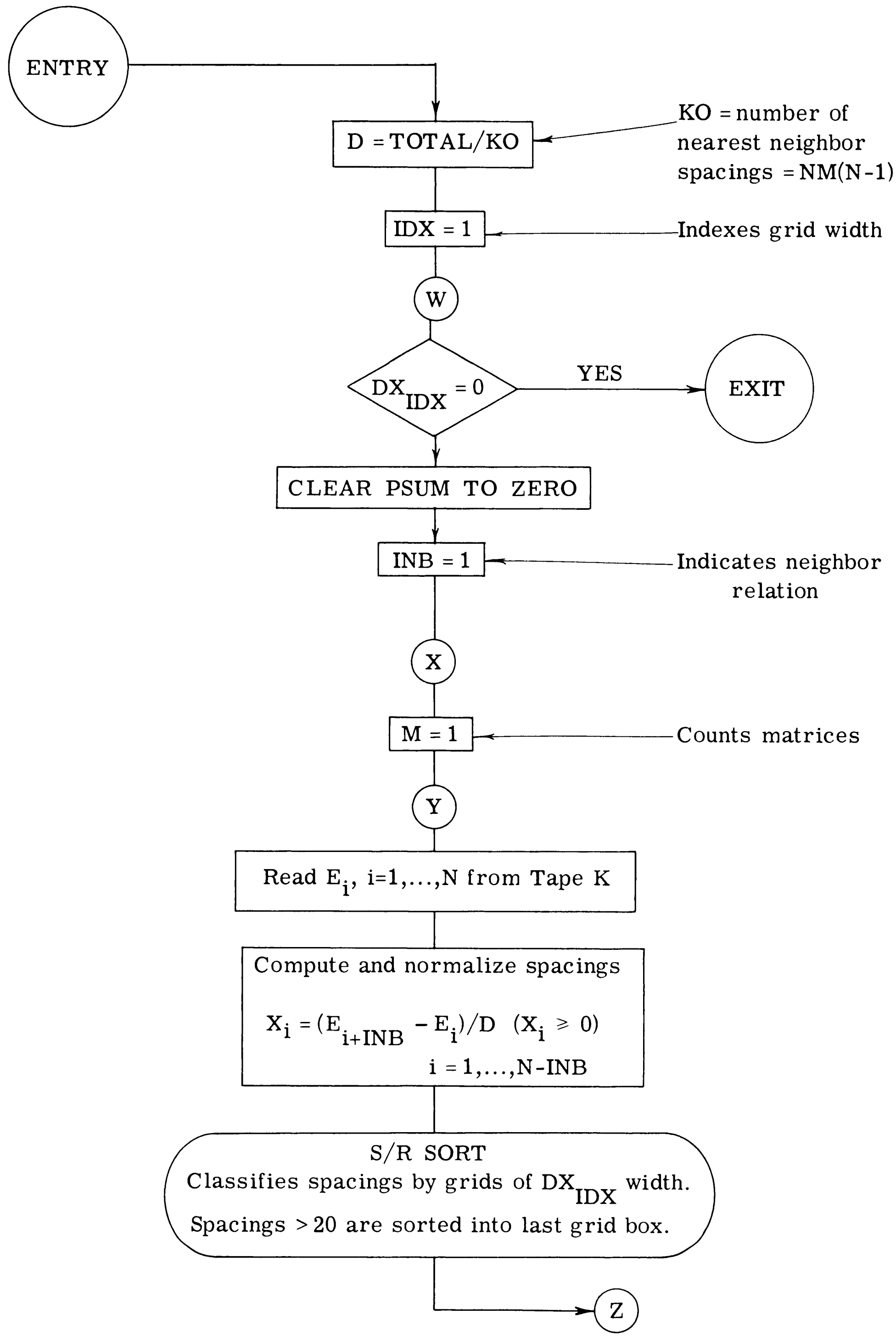
2. For each neighbor relation, INB = 1,. . .,NB, the eigenvalue spacings are computed and normalized: $X_i = (E_{i+INB} - E_i)/D$, (i=1,. . .,N-INB). Since the eigenvalues were ordered from smallest up, the spacings are all non-negative.

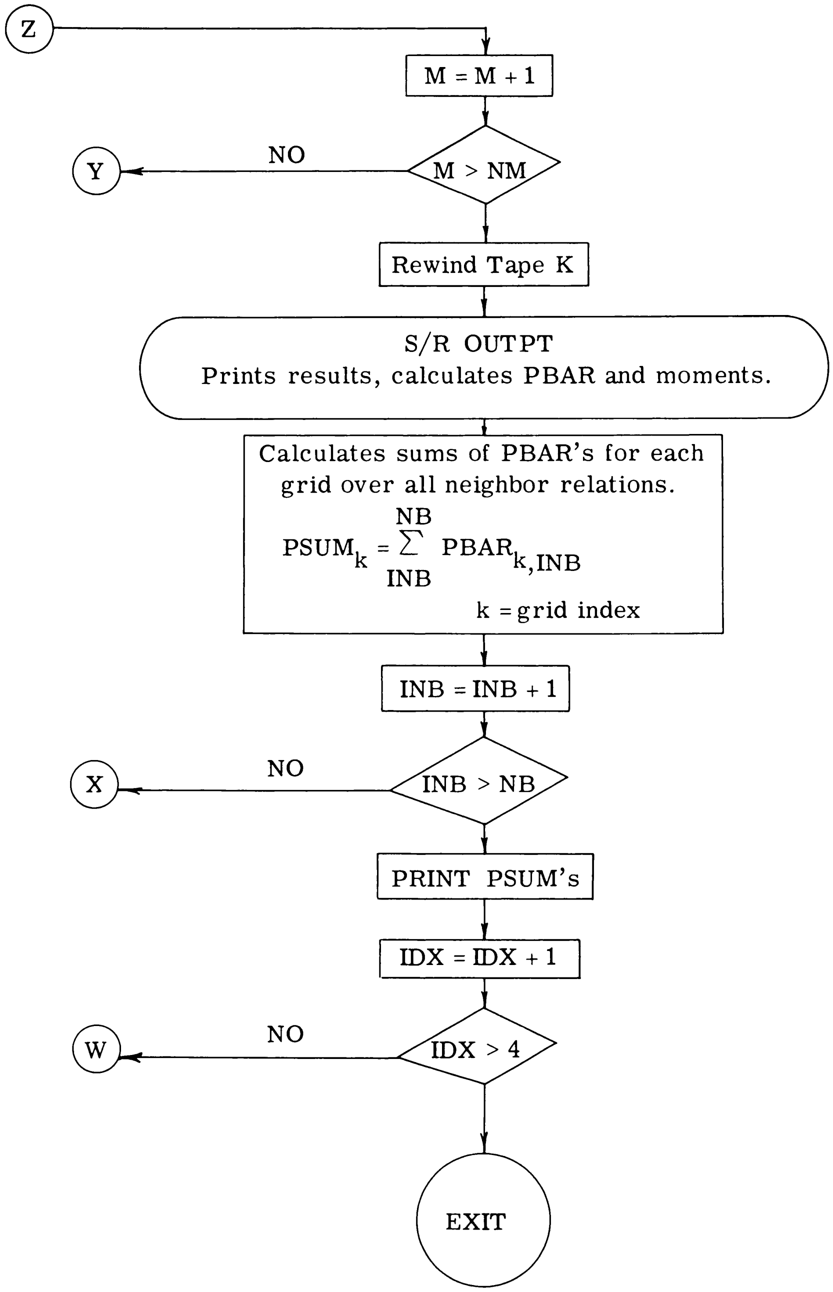
3. For each neighbor relation separately, subroutine SORT classifies the spacings by grids of width DX, putting spacings > 20 into the last grid box. The results are printed and PBAR and the moments computed by subroutine OUTPT for each neighbor relation.

4. Calculates the sums of PBAR's for each grid over all neighbor relations: $PSUM_K = \sum_{INB=1}^{NB} PBAR_{K,INB}$, K is index of grids. These results are printed.

Provision has been made to repeat this process for up to four different grid widths.

SUBROUTINE SPACE




Z
M = M + 1
NO
Y
M > NM
Rewind Tape K
S/R OUTPT
Prints results, calculates PBAR and moments.
Calculates sums of PBAR's for each grid over all neighbor relations.
$PSUM_k = \sum_{INB}^{NB} PBAR_{k,INB}$
k = grid index
INB = INB + 1
NO
X
INB > NB
PRINT PSUM's
IDX = IDX + 1
NO
W
IDX > 4
EXIT

SPACE   RØUTINE TØ HANDLE SPACINGS

```
C                                                                               SPACE001
C      CALLING SEQUENCE IS                                                      SPACE002
C                CALL SPACE                                                     SPACE003
C                                                                               SPACE004
       SUBRØUTINESPACE                                                          SPACE005
C                                                                               SPACE006
       DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)SPACE007
      1          ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)SPACE008
       CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,           SPACE009
      1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,         SPACE010
      2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM                       SPACE011
C                                                                               SPACE012
C      CØMPUTE NØRMALIZATIØN FACTØR                                             SPACE013
C                                                                               SPACE014
       AKØ=NM*NT                                                                SPACE015
       D=TØTAL/AKØ                                                              SPACE016
       GRID=0.                                                                  SPACE017
       CØNST=1.                                                                 SPACE018
C                                                                               SPACE019
C      CØMPUTE, NØRMALIZE AND SØRT SPACINGS                                     SPACE020
C                                                                               SPACE021
   10  DØ170IDX=1,4                                                             SPACE022
       IF(DX(IDX))20,180,20                                                     SPACE023
   20  XMID=DX(IDX)/2.                                                          SPACE024
       NGS=20./DX(IDX)+1.                                                       SPACE025
       DØ30I=1,NGS                                                              SPACE026
   30  PSUM(I)=0.                                                               SPACE027
       MAXG=1                                                                   SPACE028
       DØ70INB=1,NB                                                             SPACE029
       NUM=N-INB                                                                SPACE030
       TØTAL=FLØATF(NUM)*FNM                                                    SPACE031
       REWIND KTAPE                                                             SPACE032
       DØ60M=1,NM                                                               SPACE033
       M=M                                                                      SPACE034
       READTAPEKTAPE,(E(I),I=1,N)                                               SPACE035
       DØ50I=1,NUM                                                              SPACE036
       IJ=I+INB                                                                 SPACE037
   50  X(I)=(E(IJ)-E(I))/D                                                      SPACE038
   60  CALLSØRT(DX(IDX),X)                                                      SPACE039
       REWINDKTAPE                                                              SPACE040
C                                                                               SPACE041
C      ØUTPUT AND CØMPUTING MØMENTS                                             SPACE042
C                                                                               SPACE043
       KNB=INB-1                                                                SPACE044
       WRITEØUTPUTTAPE6,100,DX(IDX),KNB                                         SPACE045
  100  FØRMAT(1H116X9H DELTAX =F6.3,9X8HNEIGHBØRI3///)                          SPACE046
  160  FØRMAT(18XF6.3,7X1PE12.4)                                                SPACE059
       WRITEØUTPUTTAPE6,110                                                     SPACE047
  110  FØRMAT(17X32H X MIDPT       CØUNT         P-BAR//)                       SPACE048
       CALLØUTPT(DX(IDX))                                                       SPACE049
C                                                                               SPACE050
C      CØMPUTE SUMS ØF PBARS                                                    SPACE051
C                                                                               SPACE052
       DØ70I=1,MAXG                                                             SPACE053
   70  PSUM(I)=PSUM(I)+PBAR(I)                                                  SPACE054
```

```
      WRITEØUTPUTTAPE6,140                                          SPACE055
 14C  FØRMAT(1H117X23H X MIDPT           P-SUM//)                   SPACE056
      DØ170K=1,MAXG                                                 SPACE057
 150  WRITEØUTPUTTAPE6,160,XMID,PSUM(K)                             SPACE058
 17C  XMID=XMID+DX(IDX)                                             SPACE060
 180  RETURN                                                        SPACE061
      END
```

C. SUBROUTINE VALUE

Calling sequence: CALL VALUE

Calculates the normalization factor, SDEN = 2*WFB*$\sqrt{N}$, where WFB is the off-diagonal scale factor, N the matrix dimension, and normalizes the eigenvalues, $E_i = \frac{E_i}{SDEN}$ (i=1,. . .N). Calls subroutine SORT to classify these eigenvalues by grids of width DE.

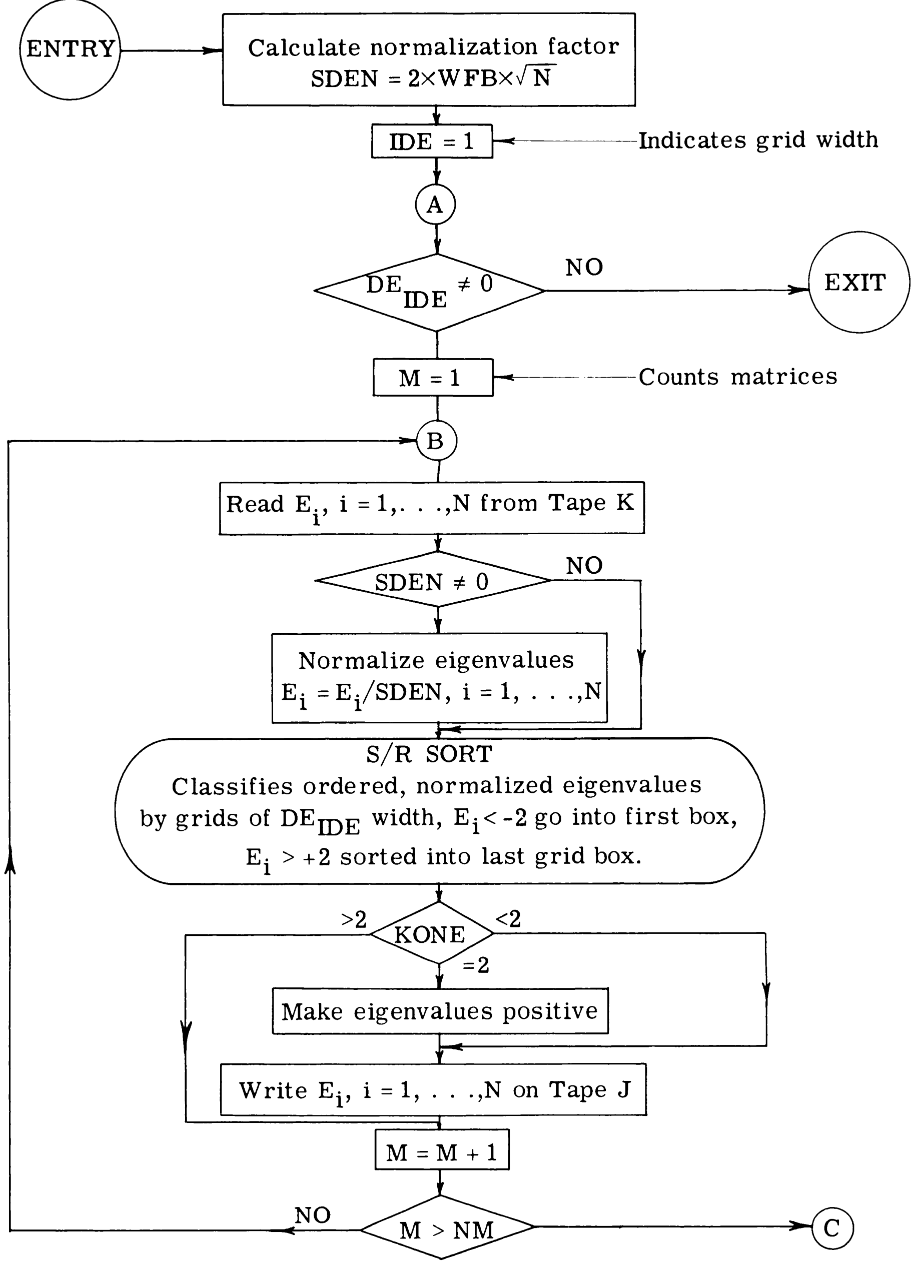
If a symmetric sorting is required, the eigenvalues are now made positive. Next they are taped for use, if desired, by subroutine SYMM or ASYM.

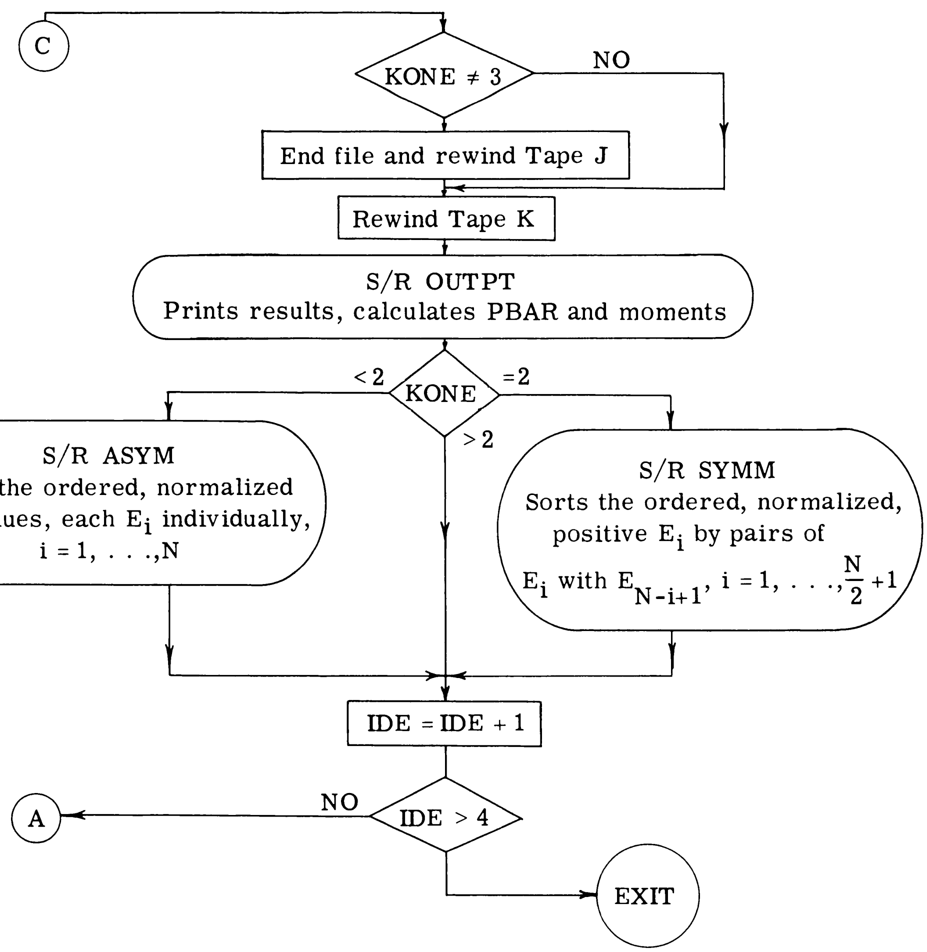
The results of the general sorting are printed and PBAR and the moments computed by subroutine OUTPT.

Finally options are tested for transfer to subroutine SYMM or ASYM for symmetric or asymmetric sorting, respectively.

Provision has been made to repeat this process for up to four different grid widths.

SUBROUTINE VALUE




C
KONE ≠ 3
NO
End file and rewind Tape J
Rewind Tape K
S/R OUTPT
Prints results, calculates PBAR and moments
< 2
KONE
=2
> 2
S/R ASYM
Sorts the ordered, normalized eigenvalues, each E_i individually, $i = 1, \ldots, N$
S/R SYMM
Sorts the ordered, normalized, positive E_i by pairs of E_i with E_{N-i+1}, $i = 1, \ldots, \frac{N}{2}+1$
IDE = IDE + 1
NO
A
IDE > 4
EXIT

VALUE

```
C      RØUTINE TØ HANDLE THE EIGENVALUES
C
C      CALLING SEQUENCE IS
C                CALL VALUE
C
       SUBRØUTINEVALUE
C
       DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)
      1          ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)
       CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,
      1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,
      2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM
C
       AN=N
       SDEN=(WFB*SQRTF(AN))+(WFB*SQRTF(AN))
       DØ140IDE=1,4
       IF(DE(IDE))10,150,10
    10 NGS=4./DE(IDE)+3.
       CØNST=1.5707963268
       GRID=-2.
       NUM=N
       TØTAL=FLØATF(NUM)*FNM
       MAXG=1
       DØ60M=1,NM
       M=M
       READTAPEKTAPE,(E(I),I=1,N)
C
C      NØRMALIZE THE EIGENVALUES
C
       DØ20I=1,N
    20 E(I)=E(I)/SDEN
C
C      SØRTING THE EIGENVALUES
C
       CALLSØRT(DE(IDE),E)
       IF(KØNE-2)50,30,60
C
C      MAKE EIGENVALUES PØSITIVE
C
    30 DØ40I=1,N21
    40 E(I)=ABSF(E(I))
    50 WRITETAPEJTAPE,(E(L),L=1,N)
    60 CØNTINUE
       IF(KØNE-3)70,80,70
    70 ENDFILEJTAPE
       REWINDJTAPE
    80 REWINDKTAPE
C
C      ØUTPUT AND CØMPUTING MØMENTS
C
       WRITEØUTPUTTAPE6,90,DE(IDE)
    90 FØRMAT(1H115X9H DELTAE =F6.3,10X12H EIGENVALUES)
       WRITEØUTPUTTAPE6,100,SDEN
   100 FØRMAT(1H011X46H EIGENVALUES NØRMALIZED BY  2*SQRTF(N*B**2)  =1PE1
      11.4//)
```

VALUE

```
      WRITEØUTPUTTAPE6,110                                              VALUE056
  110 FØRMAT(17X36H E MIDPT       CØUNT      P-BAR*(PI/2)//)            VALUE057
      XMID=-2.+DE(IDE)/2.                                               VALUE058
      CALLØUTPT(DE(IDE))                                                VALUE059
C                                                                       VALUE060
C     ØPTIØN FØR SYMMETRIC ØR ASYMMETRIC SØRTING                        VALUE061
C                                                                       VALUE062
      IF(KØNE-2)120,130,140                                             VALUE063
  120 CALLASYM(DE(IDE))                                                 VALUE064
      GØTØ140                                                           VALUE065
  130 CALLSYMM(DE(IDE))                                                 VALUE066
  140 CØNTINUE                                                          VALUE067
  150 RETURN                                                            VALUE068
      END
```

C1. SUBROUTINE SYMM

Calling sequence: CALL SYMM (DEL)

DEL = grid width

Uses subroutine SORT to classify the ordered, positive eigenvalues, E_i (i=1,. . .,N) in pairs of the highest and lowest, E_1 and E_N, the second highest and second lowest, E_2 and E_{N-1}, . . .E_i and E_{N-i+1}, as the plus-minus symmetry of the input Gaussians warrants.

After sorting each pair from all NM matrices, subroutine OUTPT is used to compute PBAR and the moments and print the results.

If the dimension N, of the matrix is odd, the middle eigenvalues are sorted alone.

SYMM

```
C      RØUTINE FØR SYMMETRIC SØRTING ØF EIGENVALUES BY PAIRS
C
C      CALLING SEQUENCE IS
C                 CALL SYMM(DEL)
C
C      DEL  IS GRID WIDTH
C
       SUBRØUTINESYMM(DEL)
C
       DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)
      1          ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)
       CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,
      1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,
      2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM
C
       CØNST=1.
       GRID=0.
       NGS=2./DEL+2.
       NUM=2
       TØTAL=FNM+FNM
       DØ70J=1,N21
       LJ=N-J+1
       MAXG=1
C
C      SØRT EIGENVALUES BY PAIRS
C
       DØ10M=1,NM
       M=M
       READTAPEJTAPE,(E(L),L=1,N)
       E(1)=E(J)
       E(2)=E(LJ)
    10 CALLSØRT(DEL,E)
       REWINDJTAPE
C
C      ØUTPUT AND CØMPUTING MØMENTS
C
       WRITEØUTPUTTAPE6,20,DEL,J,LJ
    20 FØRMAT(1H111X9H DELTAE =F6.3,10X13H EIGENVALUES(I2,4H), (I2,1H))
       WRITEØUTPUTTAPE6,30,SDEN
    30 FØRMAT(1H011X46H EIGENVALUES NØRMALIZED BY  2*WFB*SQRTF(N)   = 1PE1
      10.4//)
       WRITEØUTPUTTAPE6,40
    40 FØRMAT(17X32H E MIDPT       CØUNT         P-BAR//)
       XMID=DEL/2.
       CALLØUTPT(DEL)
       IF(J-N2)70,50,70
    50 IF(N2+N2-N)60,80,80
    60 NUM=1
       TØTAL=FNM
    70 CØNTINUE
    80 RETURN
       END
```

C2. SUBROUTINE ASYM

Calling sequence: CALL ASYM (DEL)

DEL = grid width

Uses subroutine SORT to classify the ordered eigenvalues, E_i (i=1,. . .,N), individually; E_1 from all NM matrices, then E_2, etc. The result of each sorting is printed, and PBAR and the moments computed by subroutine OUTPT before the next set of E_i's is sorted.

ASYM

```
C      ROUTINE FØR ASYMMETRIC SØRTING ØF EIGENVALUES BY SINGLES
C
C      CALLING SEQUENCE IS
C                CALL ASYM(DEL)
C
C      DEL   IS GRID WIDTH
C
       SUBRØUTINEASYM(DEL)
C
       DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)
      1          ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)
       CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,
      1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,
      2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM
C
C      SØRT EIGENVALUES BY SINGLES
C
       CØNST=1.
       GRID=-2.
       NUM=1
       TØTAL=FNM
       DØ50J=1,N
       MAXG=1
       DØ10M=1,NM
       M=M
       READTAPEJTAPE,(E(L),L=1,N)
    10 CALLSØRT(DEL,E(J))
       REWINDJTAPE
C
C      ØUTPUT AND CØMPUTING MØMENTS
C
       WRITEØUTPUTTAPE6,20,DEL,J
    20 FØRMAT(1H114X9H DELTAE =F6.3,10X12H EIGENVALUE(I2,1H))
       WRITEØUTPUTTAPE6,30,SDEN
    30 FØRMAT(1H011X46H EIGENVALUES NØRMALIZED BY  2*WFB*SQRTF(N)  = 1PE1
      10.4//)
       WRITEØUTPUTTAPE6,40
    40 FØRMAT(17X32H E MIDPT       CØUNT         P-BAR//)
       XMID=-2.+DEL/2.
    50 CALLØUTPT(DEL)
       RETURN
       END
```

D. SUBROUTINE VECTOR

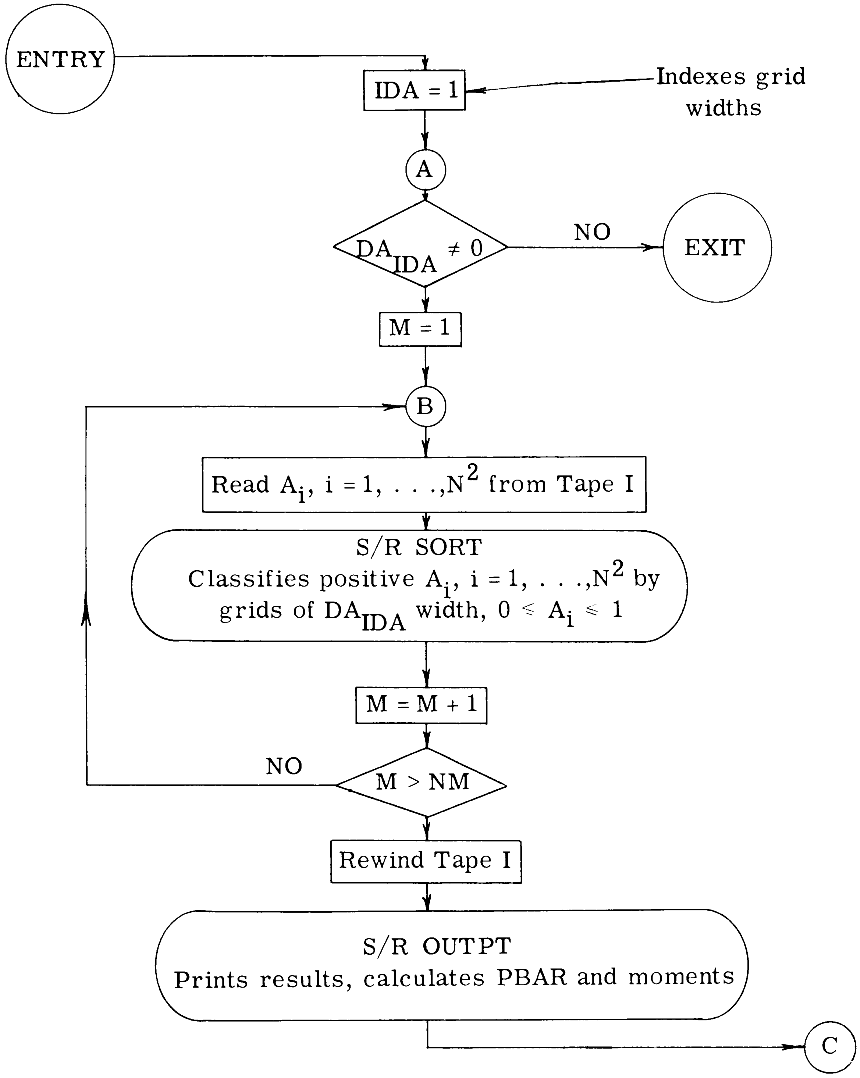
Calling sequence: CALL VECTOR

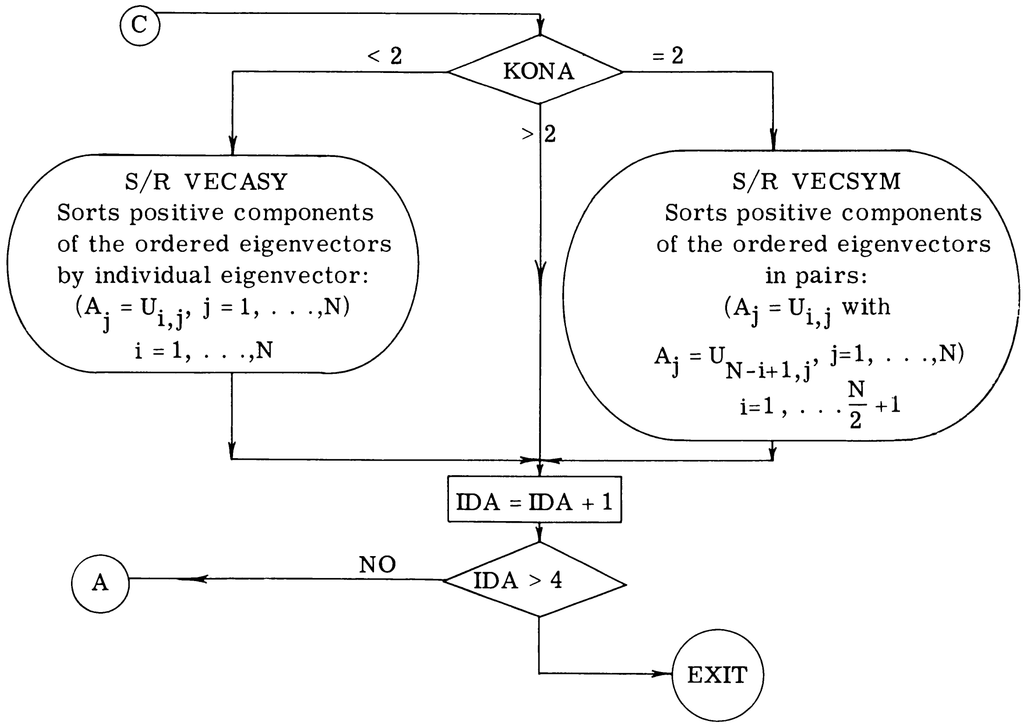
Classifies the positive eigenvector components, A_i $(i=1,...N^2)$ by grids of width DA using subroutine SORT. The results are printed and PBAR and the moments computed by subroutine OUTPT.

Then options are tested for transfer to subroutine VECSYM or VECASY for symmetric or asymmetric sorting of the eigenvectors, respectively.

Provision has been made to repeat this process for up to four different grid widths.

SUBROUTINE VECTOR





C
KONA
< 2
= 2
> 2
S/R VECASY
Sorts positive components
of the ordered eigenvectors
by individual eigenvector:
$(A_j = U_{i,j},\ j = 1, \ldots, N)$
$i = 1, \ldots, N$
S/R VECSYM
Sorts positive components
of the ordered eigenvectors
in pairs:
$(A_j = U_{i,j}$ with
$A_j = U_{N-i+1,j},\ j=1, \ldots, N)$
$i=1, \ldots \frac{N}{2}+1$
IDA = IDA + 1
IDA > 4
NO
A
EXIT

VECTØR

```
C      RØUTINE TØ HANDLE THE EIGENVECTØR CØMPØNENTS                     VECTØR01
C                                                                       VECTØR02
C      CALLING SEQUENCE IS                                              VECTØR03
C               CALL VECTØR                                             VECTØR04
C                                                                       VECTØR05
       SUBRØUTINEVECTØR                                                 VECTØR06
C                                                                       VECTØR07
       DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)VECTØR08
      1          ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)VECTØR09
       CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,    VECTØR10
      1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,  VECTØR11
      2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM                VECTØR12
C                                                                       VECTØR13
       CØNST=1.                                                         VECTØR14
       GRID=0.                                                          VECTØR15
       DØ70IDA=1,4                                                      VECTØR16
       IF(DA(IDA))10,80,10                                              VECTØR17
    10 NGS=1./DA(IDA)+1.                                                VECTØR18
       NUM=NS                                                           VECTØR19
       TØTAL=FLØATF(NUM)*FNM                                            VECTØR20
       MAXG=1                                                           VECTØR21
C                                                                       VECTØR22
C      SØRTING THE EIGENVECTØR CØMPØNENTS                               VECTØR23
C                                                                       VECTØR24
       DØ20M=1,NM                                                       VECTØR25
       M=M                                                              VECTØR26
       READTAPEITAPE,(A(L),L=1,NS)                                      VECTØR27
    20 CALLSØRT(DA(IDA),A)                                              VECTØR28
       REWINDITAPE                                                      VECTØR29
C                                                                       VECTØR30
C      ØUTPUT AND CØMPUTING MØMENTS                                     VECTØR31
C                                                                       VECTØR32
       WRITEØUTPUTTAPE6,30,DA(IDA)                                      VECTØR33
    30 FØRMAT(1H110X9H DELTAA =F6.3,10X23H EIGENVECTØR CØMPØNENTS//)    VECTØR34
       WRITEØUTPUTTAPE6,40                                              VECTØR35
    40 FØRMAT(17X32H A MIDPT      CØUNT        P-BAR//)                 VECTØR36
       XMID=DA(IDA)/2.                                                  VECTØR37
       CALLØUTPT(DA(IDA))                                               VECTØR38
       IF(KØNA-2)50,60,70                                               VECTØR39
    50 CALLVECASY(DA(IDA))                                              VECTØR40
       GØ TØ 70                                                         VECTØR41
    60 CALLVECSYM(DA(IDA))                                              VECTØR42
    70 CØNTINUE                                                         VECTØR43
    80 RETURN                                                           VECTØR44
       END
```

D1. SUBROUTINE VECSYM

Calling sequence: CALL VECSYM (DAL)

DAL = grid width

Sorts the positive components, A_i ($i=1,\ldots,N$), of symmetric pairs of the eigenvectors which have been reordered to correspond with the ordering of the eigenvalues. The components of the first and last vector are sorted together by subroutine SORT, the results are printed, and PBAR and the moments computed by subroutine OUTPT. Then the components of the second and next to last vector are sorted and the results printed, etc.

If the dimension, N, of the matrix is odd, the components of the middle vector are sorted by themselves.

VECSYM

```
C      RØUTINE FØR SYMMETRIC SØRTING ØF EIGENVECTØRS BY PAIRS           VECSYM01
C                                                                       VECSYM02
C      CALLING SEQUENCE IS                                              VECSYM03
C                CALL VECSYM(DAL)                                       VECSYM04
C                                                                       VECSYM05
C      DAL   IS GRID WIDTH                                              VECSYM06
C                                                                       VECSYM07
       SUBRØUTINEVECSYM(DAL)                                            VECSYM08
C                                                                       VECSYM09
       DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)VECSYM10
      1          ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)VECSYM11
       CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,    VECSYM12
      1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,  VECSYM13
      2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM               VECSYM14
C                                                                       VECSYM15
       NUM=N+N                                                          VECSYM16
       TØTAL=FLØATF(NUM)*FNM                                            VECSYM17
       CØNST=1.                                                         VECSYM18
       DØ70K=1,N21                                                      VECSYM19
       MAXG=1                                                           VECSYM20
       NK=N*(K-1)                                                       VECSYM21
       NKN=NK+N                                                         VECSYM22
       DØ20M=1,NM                                                       VECSYM23
       M=M                                                              VECSYM24
       READTAPEITAPE,(A(L),L=1,NS)                                      VECSYM25
       DØ10I=1,N                                                        VECSYM26
       NKI=NK+I                                                         VECSYM27
       A(I)=A(NKI)                                                      VECSYM28
       IN=I+N                                                           VECSYM29
       NSI=NS-NKN+I                                                     VECSYM30
    10 A(IN)=A(NSI)                                                     VECSYM31
    20 CALLSØRT(DAL,A)                                                  VECSYM32
       REWINDITAPE                                                      VECSYM33
       LN=N-K+1                                                         VECSYM34
       WRITEØUTPUTTAPE6,30,DAL,K,LN                                     VECSYM35
    30 FØRMAT(1H113X9H DELTAA =F6.3,10X14H EIGENVECTØRS(I2,4H), (I2,1H)) VECSYM36
       WRITEØUTPUTTAPE6,40                                              VECSYM37
    40 FØRMAT(1H016X32H A MIDPT       CØUNT          P-BAR//)           VECSYM38
       XMID=DA/2.                                                       VECSYM39
       CALLØUTPT(DAL)                                                   VECSYM40
       IF(K-N2)70,50,70                                                 VECSYM41
    50 IF(N2+N2-N)60,80,80                                              VECSYM42
    60 NUM=N                                                            VECSYM43
       TØTAL=FLØATF(NUM)*FNM                                            VECSYM44
    70 CØNTINUE                                                         VECSYM45
    80 RETURN                                                           VECSYM46
       END
```

D2. SUBROUTINE VECASY

Calling sequence: CALL VECASY (DAL)

DAL = grid width

Sorts individually, using subroutine SORT, the positive components, A_i (i=1,. . .,N), of each of the eigenvectors which have been reordered to correspond with the ordering of the eigenvalues. Uses subroutine OUTPT to print results and compute PBAR and the moments for each vector before sorting the next one.

VECASY

```
C      RØUTINE FØR ASYMMETRIC SØRTING ØF EIGENVECTØRS BY SINGLES         VECASY01
C                                                                        VECASY02
C      CALLING SEQUENCE IS                                               VECASY03
C                CALL VECASY(DAL)                                        VECASY04
C                                                                        VECASY05
C      DAL   IS GRID WIDTH                                               VECASY06
C                                                                        VECASY07
       SUBRØUTINEVECASY(DAL)                                             VECASY08
C                                                                        VECASY09
       DIMENSIØN A(2500),PBAR(2003),PSUM(2003),H(50,50),U(50,50),BL(1275)VECASY10
      1           ,E(50),HD(50),X(50),DX(4),DE(4),DA(4),DAY(2),IGRID(2003)VECASY11
       CØMMØN A,PBAR,PSUM,H,U,BL,E,HD,X,DX,DE,DA,DAY,W,WFA,WFB,GRID,     VECASY12
      1 XMID,SDEN,T,CØNST,FNM,TØTAL,IGRID,ITAPE,JTAPE,KTAPE,M,N,NM,NB,   VECASY13
      2 KØNE,KØNA,KØNN,KØNX,MAXG,NGS,NS,NT,KE,N2,N21,NUM                 VECASY14
C                                                                        VECASY15
       NUM=N                                                             VECASY16
       TØTAL=FLØATF(NUM)*FNM                                             VECASY17
       CØNST=1.                                                          VECASY18
       DØ50K=1,N                                                         VECASY19
       MAXG=1                                                            VECASY20
       NK=N*(K-1)                                                        VECASY21
       DØ20M=1,NM                                                        VECASY22
       M=M                                                               VECASY23
       READTAPEITAPE,(A(L),L=1,NS)                                       VECASY24
       DØ10I=1,N                                                         VECASY25
       NKI=NK+I                                                          VECASY26
   10  A(I)=A(NKI)                                                       VECASY27
   20  CALLSØRT(DAL,A)                                                   VECASY28
       REWINDITAPE                                                       VECASY29
       WRITEØUTPUTTAPE6,30,DAL,K                                         VECASY30
   30  FØRMAT(1H113X9H DELTAA =F6.3,10X13H EIGENVECTØR(I2,1H))           VECASY31
       WRITEØUTPUTTAPE6,40                                               VECASY32
   40  FØRMAT(1H016X32H A MIDPT       CØUNT         P-BAR//)             VECASY33
       XMID=DA/2.                                                        VECASY34
   50  CALLØUTPT(DAL)                                                    VECASY35
       RETURN                                                            VECASY36
       END
```

E. SUBROUTINE SORT

Calling sequence: CALL SORT (DD, V)

DD = grid width

V = array to be sorted

In addition, SORT expects to find the following arguments in COMMON:

NUM = number of values in V to be sorted

M = matrix count

NGS = number of grids

GRID = origin of grids

IGRID = array for counts

MAXG = will be set to highest index used in IGRID

Counts how many elements of V fall into each of NGS intervals of origin GRID and width DD, and stores these counts into an array $IGRID_i$, $i = 1, \ldots MAXG$. If any element of V is less than GRID, or greater than GRID + NGS * DD, the count will go into the first or last box of IGRID respectively.

SØRT SØRTING SUBRØUTINE

```
                          *      CALLING SEQUENCE IS                    SØRT0001
                          *              CALLSØRT(DD,V)                 SØRT0002
                          *              DD=GRID WIDTH                  SØRT0003
                          *              V=ARRAY TØ BE SØRTED           SØRT0004
                    00002        ENTRY   SØRT                           SØRT0005


00002  0634 00 1 00052   SØRT   SXA     ØUT,1                           SØRT0008
00003  0634 00 2 00053          SXA     ØUT+1,2                         SØRT0009
00004  0500 00 0 42300          CLA     M                               SØRT0010
00005  0402 00 0 00055          SUB     ØNED                            SØRT0011
00006 -0100 00 0 00022          TNZ     NØT                             SØRT0012
00007  0500 00 4 00002          CLA     2,4                             SØRT0013
00010  0400 00 0 00056          ADD     =1                              SØRT0014
00011  0621 00 0 00023          STA     V                               SØRT0015
00012  0500 00 0 42267          CLA     NGS                             SØRT0016
00013  0622 00 0 00021          STD     NG                              SØRT0017
00014  0500 00 0 42261          CLA     NUM                             SØRT0018
00015  0622 00 0 00051          STD     NU                              SØRT0019
00016  0774 00 1 00001          AXT     1,1                             SØRT0020
00017  0600 00 1 46227          STZ     IGRID+1,1                       SØRT0021
00020  1 00001 1 00021          TXI     *+1,1,1                         SØRT0022
00021 -3 00000 1 00017   NG     TXL     *-2,1,**                        SØRT0023
00022  0774 00 1 00001   NØT    AXT     1,1                             SØRT0024
00023  0500 00 1 00000   V      CLA     **,1                            SØRT0025
00024  0302 00 0 46235          FSB     GRID                            SØRT0026
00025  0120 00 0 00030          TPL     *+3                             SØRT0027
00026  0500 00 0 00055          CLA     ØNED                            SØRT0028
00027  0020 00 0 00041          TRA     SX                              SØRT0029
00030  0241 60 4 00001          FDP*    1,4                             SØRT0030
00031  0131 00 0 00000          XCA                                     SØRT0031
00032  0300 00 0 00060          FAD     =Ø233400000000                  SØRT0032
00033 -0320 00 0 00057          ANA     =Ø77777                         SØRT0033
00034  0767 00 0 00022          ALS     18                              SØRT0034
00035  0400 00 0 00055          ADD     ØNED                            SØRT0035
00036  0340 00 0 42267          CAS     NGS                             SØRT0036
00037  0500 00 0 42267          CLA     NGS                             SØRT0037
00040  0761 00 0 00000          NØP                                     SØRT0038
00041 -0734 00 2 00000   SX     PDX     ,2                              SØRT0039
00042  0340 00 0 42270          CAS     MAXG                            SØRT0040
00043  0601 00 0 42270          STØ     MAXG                            SØRT0041
00044  0761 00 0 00000          NØP                                     SØRT0042
00045  0500 00 2 46227          CLA     IGRID+1,2                       SØRT0043
00046  0400 00 0 00056          ADD     =1                              SØRT0044
00047  0601 00 2 46227          STØ     IGRID+1,2                       SØRT0045
00050  1 00001 1 00051          TXI     *+1,1,1                         SØRT0046
00051 -3 00000 1 00023   NU     TXL     V,1,**                          SØRT0047
00052  0774 00 1 00000   ØUT    AXT     **,1                            SØRT0048
00053  0774 00 2 00000          AXT     **,2                            SØRT0049
00054  0020 00 4 00003          TRA     3,4                             SØRT0050
00055  0 00001 0 00000   ØNED   PZE     ,,1                             SØRT0051
                042261   NUM    BØØL    42261      NØ.TØ BE SØRTED      SØRT0052
                042300   M      BØØL    42300      MATRIX CØUNT         SØRT0053
                042267   NGS    BØØL    42267      NØ.ØF GRIDS          SØRT0054
                042270   MAXG   BØØL    42270                           SØRT0055
                046235   GRID   BØØL    46235      ØRIGIN               SØRT0056
                046226   IGRID  BØØL    46226      ARRAY ØF CØUNTS      SØRT0057
                                END                                     SØRT0058
```

F. SUBROUTINE OUTPT

Calling sequence: CALL OUTPT (DD)

DD = grid width

OUTPT also expects to find the following arguments in COMMON:

MAXG: Highest grid index

TOTAL: Total number of counts

IGRID: Array for counts

PBAR: Corresponding array for normalized counts

CONST: A constant used to calculate PBAR

XMID: The mid-point of the first interval.

Calculates the PBAR corresponding to each count in IGRID, where

$$PBAR = \frac{CONST * COUNT}{TOTAL * DD}$$

and the moments M_0, M_1, M_2, M_3, M_4

$$M_k = \frac{1}{DD} \sum_{i=1}^{TOTAL} PBAR_i * XMID_i^{k-1}$$

These results are written on the output tape for printing as follows

- A table with columns for:

  XMID: mid-point of interval

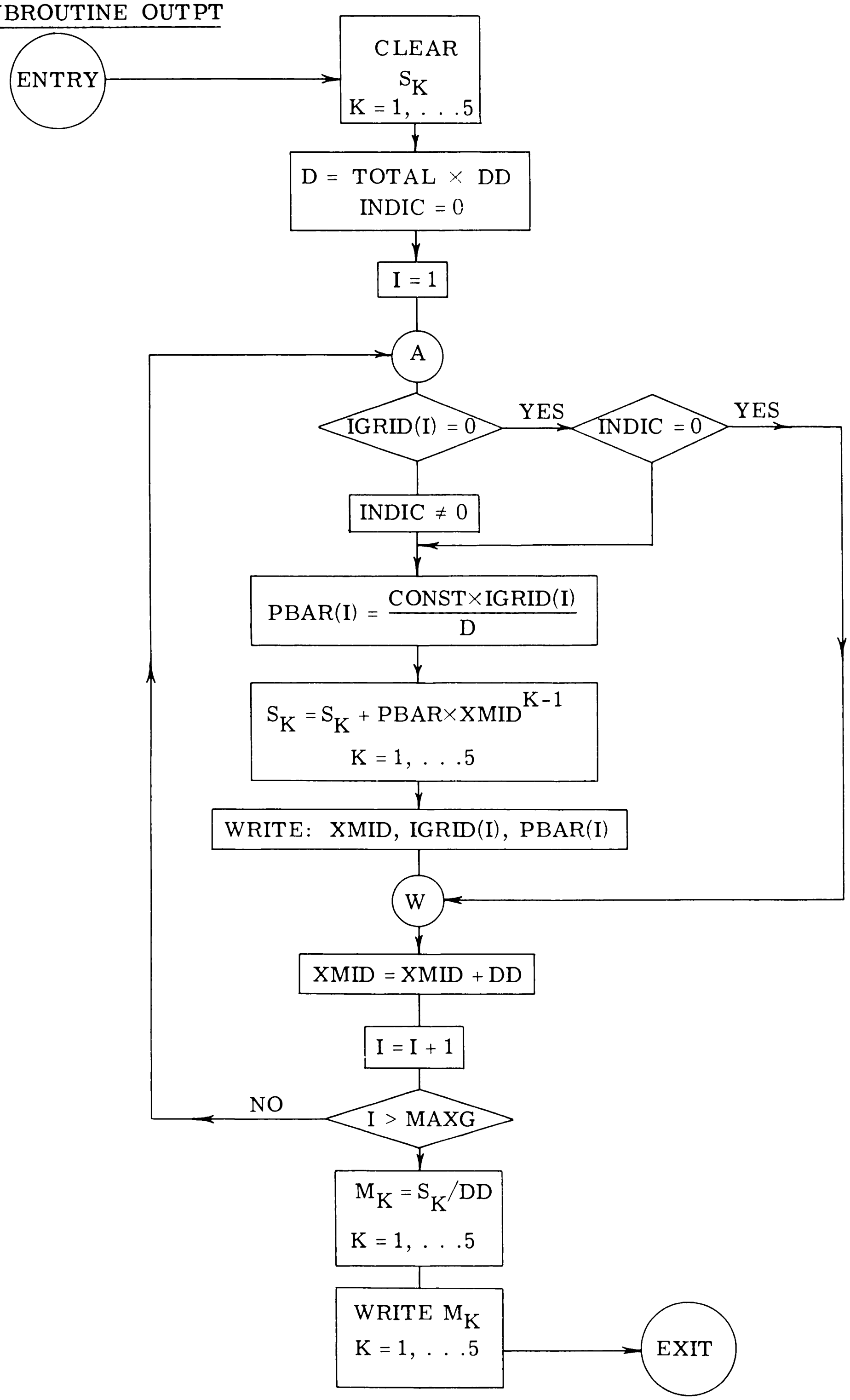
  IGRID: the count corresponding to XMID

  PBAR: corresponding to IGRID

  This table starts at the first non-zero IGRID and ends at $IGRID_{MAXG}$

- The TOTAL count, and the moments.

SUBROUTINE OUTPT



ØUTPT COMPUTES MØMENTS AND WRITES ØUTPUT

```
                         *     CALLING SEQUENCE IS                            ØUTPT001
                         *               CALLØUTPT(DD)                        ØUTPT002
                         *               DD=GRID WIDTH                        ØUTPT003
                  00004          ENTRY   ØUTPT                                ØUTPT004

00000   746263303460     (STH)
00001   742631433460     (FIL)


00004   0634 00 4 00124   ØUTPT SXA      EXIT+1,4                             ØUTPT007
00005   0634 00 2 00123         SXA      EXIT,2                               ØUTPT008
00006   0500 60 4 00001         CLA*     1,4                                  ØUTPT009
00007   0601 00 0 00152         STØ      DD                                   ØUTPT010
00010   0500 00 0 46234         CLA      XMID                                 ØUTPT011
00011   0601 00 0 00163         STØ      XCMID                                ØUTPT012
00012   0774 00 2 00005         AXT      5,2                                  ØUTPT013
00013   0600 00 2 00163         STZ      SIG+1,2                              ØUTPT014
00014   2 00001 2 00013         TIX      *-1,2,1                              ØUTPT015
00015   0560 00 0 46227         LDQ      TØTAL                                ØUTPT016
00016   0260 00 0 00152         FMP      DD                                   ØUTPT017
00017   0601 00 0 00154         STØ      WS+1                                 ØUTPT018
00020   0600 00 0 00155         STZ      INDIC                                ØUTPT019
00021   0500 00 0 42270         CLA      MAXG                                 ØUTPT020
00022   0622 00 0 00072         STD      ØX                                   ØUTPT021
00023   0774 00 2 00001         AXT      1,2                                  ØUTPT022
00024   0500 00 2 46227   ØA    CLA      IGRID+1,2                            ØUTPT023
00025  -0100 00 0 00032         TNZ      ØB                                   ØUTPT024
00026   0600 00 2 72556         STZ      PBAR+1,2                             ØUTPT025
00027   0520 00 0 00155         ZET      INDIC                                ØUTPT026
00030   0020 00 0 00054         TRA      ØE                                   ØUTPT027
00031   0020 00 0 00066         TRA      ØW                                   ØUTPT028
00032   0601 00 0 00155   ØB    STØ      INDIC                                ØUTPT029
00033  -0501 00 0 00165         ØRA      =Ø233000000000                       ØUTPT030
00034   0300 00 0 00165         FAD      =Ø233000000000                       ØUTPT031
00035   0601 00 2 46227         STØ      IGRID+1,2                            ØUTPT032
00036   0241 00 0 00154         FDP      WS+1                                 ØUTPT033
00037   0260 00 0 46231         FMP      CØNST                                ØUTPT034
00040   0601 00 2 72556         STØ      PBAR+1,2                             ØUTPT035
00041   0601 00 0 00153         STØ      WS                                   ØUTPT036
00042   0300 00 0 00162         FAD      SIG                                  ØUTPT037
00043   0601 00 0 00162         STØ      SIG                                  ØUTPT038
00044   0774 00 4 00002         AXT      2,4                                  ØUTPT039
00045   0560 00 0 00153   ØC    LDQ      WS                                   ØUTPT040
00046   0260 00 0 00163         FMP      XCMID                                ØUTPT041
00047   0601 00 0 00153         STØ      WS                                   ØUTPT042
00050   0300 00 4 00163         FAD      SIG+1,4                              ØUTPT043
00051   0601 00 4 00163         STØ      SIG+1,4                              ØUTPT044
00052   1 00001 4 00053         TXI      *+1,4,1                              ØUTPT045
00053  -3 00005 4 00045         TXL      ØC,4,5                               ØUTPT046
00054  -0500 00 0 00164   ØE    CAL      =Ø6000000                            ØUTPT047
00055   0074 00 4 00000         TSX      $(STH),4                             ØUTPT048
00056   0 00000 0 00151         PZE      FMG                                  ØUTPT049
00057   0560 00 0 00163         LDQ      XCMID                                ØUTPT050
00060  -1 00000 0 00000         STR                                           ØUTPT051
00061   0560 00 2 46227         LDQ      IGRID+1,2                            ØUTPT052
00062  -1 00000 0 00000         STR                                           ØUTPT053
```

```
00063   0560 00 2 72556            LDQ     PBAR+1,2               ØUTPT054
00064  -1 00000 0 00000            STR                            ØUTPT055
00065   0074 00 4 00001            TSX     $(FIL),4               ØUTPT056
00066   0500 00 0 00163     ØW     CLA     XCMID                  ØUTPT057
00067   0300 00 0 00152            FAD     DD                     ØUTPT058
00070   0601 00 0 00163            STØ     XCMID                  ØUTPT059
00071   1 00001 2 00072            TXI     *+1,2,1                ØUTPT060
00072  -3 00000 2 00024     ØX     TXL     ØA,2,**                ØUTPT061
00073  -0500 00 0 00164            CAL     =Ø6000000              ØUTPT062
00074   0074 00 4 00000            TSX     $(STH),4               ØUTPT063
00075   0 00000 0 00144            PZE     FMI                    ØUTPT064
00076   0560 00 0 46227            LDQ     TØTAL                  ØUTPT065
00077  -1 00000 0 00000            STR                            ØUTPT066
00100   0074 00 4 00001            TSX     $(FIL),4               ØUTPT067
00101  -0500 00 0 00164            CAL     =Ø6000000              ØUTPT068
00102   0074 00 4 00000            TSX     $(STH),4               ØUTPT069
00103   0 00000 0 00140            PZE     FMP                    ØUTPT070
00104   0074 00 4 00001            TSX     $(FIL),4               ØUTPT071
00105   0774 00 2 00005            AXT     5,2                    ØUTPT072
00106   0560 00 2 00163     ØD     LDQ     SIG+1,2                ØUTPT073
00107   0260 00 0 00152            FMP     DD                     ØUTPT074
00110   0601 00 2 00163            STØ     SIG+1,2                ØUTPT075
00111   2 00001 2 00106            TIX     ØD,2,1                 ØUTPT076
00112   0774 00 2 00001            AXT     1,2                    ØUTPT077
00113  -0500 00 0 00164            CAL     =Ø6000000              ØUTPT078
00114   0074 00 4 00000            TSX     $(STH),4               ØUTPT079
00115   0 00000 0 00130            PZE     FMJ                    ØUTPT080
00116   0560 00 2 00163            LDQ     SIG+1,2                ØUTPT081
00117  -1 00000 0 00000            STR                            ØUTPT082
00120   1 00001 2 00121            TXI     *+1,2,1                ØUTPT083
00121  -3 00005 2 00116            TXL     *-3,2,5                ØUTPT084
00122   0074 00 4 00001            TSX     $(FIL),4               ØUTPT085
00123   0774 00 2 00000     EXIT   AXT     **,2                   ØUTPT086
00124   0774 00 4 00000            AXT     **,4                   ØUTPT087
00125   0020 00 4 00002            TRA     2,4                    ØUTPT088
00126   346060606060               BCI     1,)                    ØUTPT089
00127   052501023304               BCI     1,5E12.4               ØUTPT090
00130   740100670147        FMJ    BCI     1,(10X1P               ØUTPT091
00131   613460606060               BCI     1,/)                   ØUTPT092
00132   033060440461               BCI     1,3H M4/               ØUTPT093
00133   306044031167               BCI     1,H M39X               ØUTPT094
00134   604402116703               BCI     1, M29X3               ØUTPT095
00135   440111670330               BCI     1,M19X3H               ØUTPT096
00136   001167033060               BCI     1,09X3H                ØUTPT097
00137   046703306044               BCI     1,4X3H M               ØUTPT098
00140   607401300001        FMP    BCI     1, (1H01               ØUTPT099
00141   023300346060               BCI     1,2.0)                 ØUTPT100
00142   466321432601               BCI     1,ØTALF1               ØUTPT101
00143   066706306063               BCI     1,6X6H T               ØUTPT102
00144   607401300001        FMI    BCI     1, (1H01               ØUTPT103
00145   346060606060               BCI     1,)                    ØUTPT104
00146   472501023304               BCI     1,PE12.4               ØUTPT105
00147   330073056701               BCI     1,.0,5X1               ØUTPT106
00150   330373260101               BCI     1,.3,F11               ØUTPT107
00151   740110672606        FMG    BCI     1,(18XF6               ØUTPT108
00152  +000000000000        DD     ØCT     0                      ØUTPT109
```

```
 ØUTPT         CØMPUTES MØMENTS AND WRITES ØUTPUT

00153 +000000000000       WS    ØCT     0,0                           ØUTPT110
00155 +000000000000       INDIC ØCT     0                             ØUTPT111
00156 +000000000000             ØCT     0,0,0,0                       ØUTPT112
00162 +000000000000       SIG   ØCT     0                             ØUTPT113
00163 +000000000000       XCMID ØCT     0                             ØUTPT114
                 042300   M     BØØL    42300   MATRIX INDEX          ØUTPT115
                 046227   TØTAL BØØL    46227   TØTAL NØ.ØF CØUNTS    ØUTPT116
                 046226   IGRID BØØL    46226   ARRAY ØF CØUNTS       ØUTPT117
                 072555   PBAR  BØØL    72555                         ØUTPT118
                 046231   CØNST BØØL    46231                         ØUTPT119
                 046234   XMID  BØØL    46234                         ØUTPT120
                 042270   MAXG  BØØL    42270                         ØUTPT121
                                END                                   ØUTPT122
```

G. OTHER SUBROUTINES

1. DATE: Calling sequence: CALL DATE (DAY)

   Can only be used with a monitor which has the date stored as BCD in location 142_8. Fetches date, inserts slashes, and stores, for example:

   08/27/ in DAY,

   62bbbb in DAY - 1 (b=blank)

   DAY can then be printed on the output by means of FORMAT (2A6).

2. CLOK: Can only be used on a 7090 equipped with a core clock. This clock adds one to the contents of location 5 every 1/60 sec.

   Calling sequence:

   CALL RCLOK: Stores the current contents of location 5.

   CALL ICLOK (IT): Subtracts from the current contents of location 5 its contents when a previous CALL RCLOK was performed; shifts the difference to the decrement and stores it in T.

   CALL FCLOK (T): Same as above except that the difference is converted to a floating point number.

3. Subroutines on the Standard FORTRAN Library Tape.

V. REMARKS

A. STORAGE REQUIREMENTS AND AVAILABLE CARD DECKS

	STORAGE[1]		DECK LABELS	
PROGRAM	DEC	OCT	SOURCE	BINARY
MAIN	956	1674	RMDOOOO-217	RMDOOOO-47
MXGEN	157	235	[2]MXNORMOO-41	MXNORMOO-08
RAN2N	75	113	[3]RAN2NOOO-73	RAN2NOOO-04
HDIAG	791	1427	HDIAGOOO-163	HDIAGOOO-36
SPACE	259	403	SPACEOOO-62	SPACEOOO-13
VALUE	241	361	VALUEOOO-69	VALUEOOO-12
SYMM	181	265	SYMMOOOO-52	SYMMOOOO-09
ASYM	139	213	ASYMOOOO-42	ASYMOOOO-07
VECTOR	158	236	VECTOROO-45	VECTOROO-08
VECSYM	222	336	VECSYMOO-47	VECSYMOO-11
VECASY	168	248	VECASYOO-37	VECASYOO-08
SORT	49	61	[3]SORTOOOO-58	SORTOOOO-03
OUTPT	118	166	[3]OUTPTOOO-122	OUTPTOOO-06
DATE	19	23	—	DATEOOOO-01
CLOK	18	22	—	CLOKOOOO-01
Other	2838	5426	On Standard Library Tape	
	6389	14365		
COMMON	14977	35201		
	21366	51566		

[1]These storage requirements are based on a maximum matrix dimension of 50×50.

[2]For the alternate matrix loading routine, substitute:

MXGEN	118	166	MXONESOO-39	MXONESOO-06

[3]These routines are coded in FAP.

B. TIMING ESTIMATES

The following table contains very rough estimates for generating 1000 matrices with normally distributed elements, diagonalizing each matrix, ordering the eigenvalues and eigenvectors, calculating the nearest neighbor spacings, and taping the eigenvalues, eigenvectors, and spacing.

N	Min	N	Min
2	2	20	200
3	3	30	630
5	5	40	1500
10	26	50	2900

The time needed to perform the various sortings and produce the output tables is not included; due to tape movement it can amount to 25 to 30% of the total time.

For input matrices containing a large number of zeros, or the ±1 input, the time is reduced slightly.

For reference, the time taken for the sample output (2000 5×5 matrices) was about 15 minutes; for 15000 4×4 matrices about one hour, and for 200 20×20 matrices with the ±1 input 1 hour.

C. RESTRICTIONS

1. The punching of a restart card every 20 minutes requires a core clock (RPQ F89349).
2. $N^2 \times NM$ must be less than 2^{27}.

VI. SAMPLE OUTPUT

RANDØM MATRIX DIAGØNALIZATIØN

PERFØRMED ØN 09/26/62

5 - DIMENSIØNAL MATRIX

WFA = 1.4142136E 00   WFB = 1.0000000E 00

INPUT DATA

```
     ITAPE = 11       JTAPE =  4      KTAPE = 14
      N =  5       NM =       2000      NB =  4
        WFA =      1.4142      WFB =     1.0000
DX ARE    0.1000   -0.        -0.        -0.
DE ARE    0.1000    0.0500    -0.        -0.
DA ARE    0.0500   -0.        -0.        -0.
 KØNE = 2   KØNA = 2   KØNN =-0   KØNX =-0
         W = 000000000000      M =         -0
                 TØTAL = 000000000000
```

DELTAX = 0.100 NEIGHBØR 0

X MIDPT	CØUNT	P-BAR
0.050	61.	7.6250E-02
0.150	195.	2.4375E-01
0.250	312.	3.9000E-01
0.350	427.	5.3375E-01
0.450	470.	5.8750E-01
0.550	562.	7.0250E-01
0.650	560.	7.0000E-01
0.750	625.	7.8125E-01
0.850	613.	7.6625E-01
0.950	595.	7.4375E-01
1.050	544.	6.8000E-01
1.150	471.	5.8875E-01
1.250	446.	5.5750E-01
1.350	392.	4.9000E-01
1.450	334.	4.1750E-01
1.550	271.	3.3875E-01
1.650	255.	3.1875E-01
1.750	191.	2.3875E-01
1.850	171.	2.1375E-01
1.950	111.	1.3875E-01
2.050	101.	1.2625E-01
2.150	81.	1.0125E-01
2.250	51.	6.3750E-02
2.350	42.	5.2500E-02
2.450	35.	4.3750E-02
2.550	26.	3.2500E-02
2.650	19.	2.3750E-02
2.750	10.	1.2500E-02
2.850	11.	1.3750E-02
2.950	3.	3.7500E-03
3.050	5.	6.2500E-03
3.150	4.	5.0000E-03
3.250	1.	1.2500E-03
3.350	3.	3.7500E-03
3.450	0.	0.
3.550	1.	1.2500E-03
3.650	1.	1.2500E-03
TØTAL	8000.	

M0	M1	M2	M3	M4
10.C000E-01	1.0005E 00	1.2915E 00	1.9870E 00	3.4955E 00

DELTAX = 0.100   NEIGHBØR 1

X MIDPT	CØUNT	P-BAR
0.250	1.	1.6667E-03
0.350	4.	6.6667E-03
0.450	9.	1.5000E-02
0.550	21.	3.5000E-02
0.650	30.	5.0000E-02
0.750	58.	9.6667E-02
0.850	92.	1.5333E-01
0.950	115.	1.9167E-01
1.050	138.	2.3000E-01
1.150	203.	3.3833E-01
1.250	237.	3.9500E-01
1.350	275.	4.5833E-01
1.450	336.	5.6000E-01
1.550	336.	5.6000E-01
1.650	368.	6.1333E-01
1.750	373.	6.2167E-01
1.850	403.	6.7167E-01
1.950	361.	6.0167E-01
2.050	324.	5.4000E-01
2.150	335.	5.5833E-01
2.250	311.	5.1833E-01
2.350	277.	4.6167E-01
2.450	238.	3.9667E-01
2.550	217.	3.6167E-01
2.650	193.	3.2167E-01
2.750	173.	2.8833E-01
2.850	134.	2.2333E-01
2.950	110.	1.8333E-01
3.050	73.	1.2167E-01
3.150	70.	1.1667E-01
3.250	45.	7.5000E-02
3.350	41.	6.8333E-02
3.450	25.	4.1667E-02
3.550	23.	3.8333E-02
3.650	20.	3.3333E-02
3.750	8.	1.3333E-02
3.850	6.	1.0000E-02
3.950	6.	1.0000E-02
4.050	5.	8.3333E-03
4.150	2.	3.3333E-03
4.250	1.	1.6667E-03
4.350	0.	0.
4.450	0.	0.
4.550	1.	1.6667E-03
4.650	1.	1.6667E-03
4.750	1.	1.6667E-03
TØTAL	6000.	

M0	M1	M2	M3	M4
10.0000E-01	1.9479E 00	4.1912E 00	9.7982E 00	2.4596E 01

DELTAX = 0.100 NEIGHBØR 2

X MIDPT	CØUNT	P-BAR
0.950	2.	5.0000E-03
1.050	0.	0.
1.150	3.	7.5000E-03
1.250	8.	2.0000E-02
1.350	12.	3.0000E-02
1.450	25.	6.2500E-02
1.550	25.	6.2500E-02
1.650	38.	9.5000E-02
1.750	60.	1.5000E-01
1.850	70.	1.7500E-01
1.950	111.	2.7750E-01
2.050	101.	2.5250E-01
2.150	157.	3.9250E-01
2.250	166.	4.1500E-01
2.350	174.	4.3500E-01
2.450	198.	4.9500E-01
2.550	191.	4.7750E-01
2.650	237.	5.9250E-01
2.750	239.	5.9750E-01
2.850	212.	5.3000E-01
2.950	215.	5.3750E-01
3.050	212.	5.3000E-01
3.150	228.	5.7000E-01
3.250	192.	4.8000E-01
3.350	162.	4.0500E-01
3.450	172.	4.3000E-01
3.550	121.	3.0250E-01
3.650	130.	3.2500E-01
3.750	103.	2.5750E-01
3.850	87.	2.1750E-01
3.950	69.	1.7250E-01
4.050	55.	1.3750E-01
4.150	57.	1.4250E-01
4.250	45.	1.1250E-01
4.350	27.	6.7500E-02
4.450	24.	6.0000E-02
4.550	20.	5.0000E-02
4.650	13.	3.2500E-02
4.750	8.	2.0000E-02
4.850	12.	3.0000E-02
4.950	4.	1.0000E-02
5.050	6.	1.5000E-02
5.150	5.	1.2500E-02
5.250	1.	2.5000E-03
5.350	3.	7.5000E-03
TØTAL	4000.	

M0	M1	M2	M3	M4
10.0000E-01	2.9213E 00	9.0213E 00	2.9299E 01	9.9637E 01

DELTAX = 0.100 NEIGHBØR 3

X MIDPT	CØUNT	P-BAR
1.750	1.	5.0000E-03
1.850	1.	5.0000E-03
1.950	0.	0.
2.050	1.	5.0000E-03
2.150	5.	2.5000E-02
2.250	7.	3.5000E-02
2.350	11.	5.5000E-02
2.450	11.	5.5000E-02
2.550	9.	4.5000E-02
2.650	15.	7.5000E-02
2.750	42.	2.1000E-01
2.850	32.	1.6000E-01
2.950	48.	2.4000E-01
3.050	51.	2.5500E-01
3.150	58.	2.9000E-01
3.250	84.	4.2000E-01
3.350	78.	3.9000E-01
3.450	81.	4.0500E-01
3.550	91.	4.5500E-01
3.650	89.	4.4500E-01
3.750	114.	5.7000E-01
3.850	112.	5.6000E-01
3.950	101.	5.0500E-01
4.050	106.	5.3000E-01
4.150	102.	5.1000E-01
4.250	97.	4.8500E-01
4.350	92.	4.6000E-01
4.450	83.	4.1500E-01
4.550	54.	2.7000E-01
4.650	66.	3.3000E-01
4.750	54.	2.7000E-01
4.850	41.	2.0500E-01
4.950	51.	2.5500E-01
5.050	37.	1.8500E-01
5.150	45.	2.2500E-01
5.250	20.	1.0000E-01
5.350	26.	1.3000E-01
5.450	15.	7.5000E-02
5.550	16.	8.0000E-02
5.650	9.	4.5000E-02
5.750	9.	4.5000E-02
5.850	4.	2.0000E-02
5.950	7.	3.5000E-02
6.050	7.	3.5000E-02
6.150	6.	3.0000E-02
6.250	3.	1.5000E-02
6.350	2.	1.0000E-02
6.450	0.	0.
6.550	4.	2.0000E-02
6.650	2.	1.0000E-02
TØTAL	2000.	

M0	M1	M2	M3	M4
10.0000E-01	3.9997E 00	1.6597E 01	7.1329E 01	3.1699E 02

X MIDPT	P-SUM
0.050	7.6250E-02
0.150	2.4375E-01
0.250	3.9167E-01
0.350	5.4042E-01
0.450	6.0250E-01
0.550	7.3750E-01
0.650	7.5000E-01
0.750	8.7792E-01
0.850	9.1958E-01
0.950	9.4042E-01
1.050	9.1000E-01
1.150	9.3458E-01
1.250	9.7250E-01
1.350	9.7833E-01
1.450	1.0400E 00
1.550	9.6125E-01
1.650	1.0271E 00
1.750	1.0154E 00
1.850	1.0654E 00
1.950	1.0179E 00
2.050	9.2375E-01
2.150	1.0771E 00
2.250	1.0321E 00
2.350	1.0042E 00
2.450	9.9042E-01
2.550	9.1667E-01
2.650	1.0129E 00
2.750	1.1083E 00
2.850	9.2708E-01
2.950	9.6458E-01
3.050	9.1292E-01
3.150	9.8167E-01
3.250	9.7625E-01
3.350	8.6708E-01
3.450	8.7667E-01
3.550	7.9708E-01
3.650	8.0458E-01
3.750	8.4083E-01
3.850	7.8750E-01
3.950	6.8750E-01
4.050	6.7583E-01
4.150	6.5583E-01
4.250	5.9917E-01
4.350	5.2750E-01
4.450	4.7500E-01
4.550	3.2167E-01
4.650	3.6417E-01
4.750	2.9167E-01
4.850	2.3500E-01
4.950	2.6500E-01
5.050	2.0000E-01
5.150	2.3750E-01
5.250	1.0250E-01
5.350	1.3750E-01
5.450	7.5000E-02
5.550	8.0000E-02
5.650	4.5000E-02
5.750	4.5000E-02
5.850	2.0000E-02
5.950	3.5000E-02
6.050	3.5000E-02
6.150	3.0000E-02
6.250	1.5000E-02
6.350	1.0000E-02
6.450	0.
6.550	2.0000E-02
6.650	1.0000E-02

DELTA E = 0.100 EIGENVALUES

EIGENVALUES NØRMALIZED BY 2*SQRTF(N*B**2) = 4.4721E 00

E MIDPT	CØUNT	P-BAR*(PI/2)
-1.550	2.	3.1416E-03
-1.450	4.	6.2832E-03
-1.350	10.	1.5708E-02
-1.250	26.	4.0841E-02
-1.150	53.	8.3252E-02
-1.050	114.	1.7907E-01
-0.950	231.	3.6285E-01
-0.850	315.	4.9480E-01
-0.750	410.	6.4403E-01
-0.650	455.	7.1471E-01
-0.550	487.	7.6498E-01
-0.450	523.	8.2153E-01
-0.350	568.	8.9221E-01
-0.250	595.	9.3462E-01
-0.150	587.	9.2206E-01
-0.050	591.	9.2834E-01
0.050	650.	1.0210E 00
0.150	619.	9.7232E-01
0.250	567.	8.9064E-01
0.350	578.	9.0792E-01
0.450	532.	8.3566E-01
0.550	489.	7.6812E-01
0.650	481.	7.5555E-01
0.750	384.	6.0319E-01
0.850	304.	4.7752E-01
0.950	205.	3.2201E-01
1.050	117.	1.8378E-01
1.150	61.	9.5819E-02
1.250	22.	3.4558E-02
1.350	16.	2.5133E-02
1.450	3.	4.7124E-03
1.550	1.	1.5708E-03
TØTAL	10000.	

M0	M1	M2	M3	M4
1.5708E 00	-2.3246E-03	4.6883E-01	-2.4816E-03	3.1156E-01

DELTAE = 0.100 EIGENVALUES(1), (5)

EIGENVALUES NØRMALIZED BY 2*WFB*SQRTF(N) = 4.4721E 00

E MIDPT	CØUNT	P-BAR
0.050	2.	5.0000E-03
0.150	14.	3.5000E-02
0.250	69.	1.7250E-01
0.350	180.	4.5000E-01
0.450	342.	8.5500E-01
0.550	550.	1.3750E 00
0.650	682.	1.7050E 00
0.750	707.	1.7675E 00
0.850	594.	1.4850E 00
0.950	433.	1.0825E 00
1.050	229.	5.7250E-01
1.150	114.	2.8500E-01
1.250	48.	1.2000E-01
1.350	26.	6.5000E-02
1.450	7.	1.7500E-02
1.550	3.	7.5000E-03
TØTAL	4000.	

M0	M1	M2	M3	M4
10.0000E-01	7.2752E-01	5.7891E-01	4.9545E-01	4.5127E-01

DELTAE = 0.100 EIGENVALUES(2), (4)

EIGENVALUES NØRMALIZED BY 2*WFB*SQRTF(N) = 4.4721E 00

E MIDPT	CØUNT	P-BAR
0.050	427.	1.0675E 00
0.150	555.	1.3875E 00
0.250	747.	1.8675E 00
0.350	828.	2.0700E 00
0.450	664.	1.6600E 00
0.550	413.	1.0325E 00
0.650	250.	6.2500E-01
0.750	87.	2.1750E-01
0.850	24.	6.0000E-02
0.950	3.	7.5000E-03
1.050	2.	5.0000E-03
TØTAL	4000.	

M0	M1	M2	M3	M4
10.0000E-01	3.4005E-01	1.4947E-01	7.5826E-02	4.2551E-02

DELTAE = 0.100 EIGENVALUES(3), (3)

EIGENVALUES NØRMALIZED BY 2*WFB*SQRTF(N) = 4.4721E 00

E MIDPT	CØUNT	P-BAR
0.050	836.	4.1800E 00
0.150	619.	3.0950E 00
0.250	342.	1.7100E 00
0.350	137.	6.8500E-01
0.450	48.	2.4000E-01
0.550	13.	6.5000E-02
0.650	4.	2.0000E-02
0.750	0.	0.
0.850	1.	5.0000E-03
TØTAL	2000.	

M0	M1	M2	M3	M4
10.0000E-01	1.5015E-01	3.5120E-02	1.0830E-02	4.0521E-03

DELTAE = 0.050 EIGENVALUES

EIGENVALUES NØRMALIZED BY 2*SQRTF(N*B**2) = 4.4721E 00

E MIDPT	CØUNT	P-BAR*(PI/2)
-1.575	1.	3.1416E-03
-1.525	1.	3.1416E-03
-1.475	2.	6.2832E-03
-1.425	2.	6.2832E-03
-1.375	2.	6.2832E-03
-1.325	8.	2.5133E-02
-1.275	10.	3.1416E-02
-1.225	16.	5.0265E-02
-1.175	24.	7.5398E-02
-1.125	29.	9.1106E-02
-1.075	48.	1.5080E-01
-1.025	66.	2.0735E-01
-0.975	92.	2.8903E-01
-0.925	139.	4.3668E-01
-0.875	135.	4.2412E-01
-0.825	180.	5.6549E-01
-0.775	197.	6.1889E-01
-0.725	213.	6.6916E-01
-0.675	222.	6.9743E-01
-0.625	233.	7.3199E-01
-0.575	246.	7.7283E-01
-0.525	241.	7.5712E-01
-0.475	282.	8.8593E-01
-0.425	241.	7.5712E-01
-0.375	285.	8.9535E-01
-0.325	283.	8.8907E-01
-0.275	300.	9.4248E-01
-0.225	295.	9.2677E-01
-0.175	292.	9.1735E-01
-0.125	295.	9.2677E-01
-0.075	318.	9.9903E-01
-0.025	273.	8.5765E-01
0.025	331.	1.0399E 00
0.075	319.	1.0022E 00
0.125	307.	9.6447E-01
0.175	312.	9.8018E-01
0.225	292.	9.1735E-01
0.275	275.	8.6394E-01
0.325	284.	8.9221E-01
0.375	294.	9.2363E-01
0.425	287.	9.0164E-01
0.475	245.	7.6969E-01
0.525	239.	7.5084E-01
0.575	250.	7.8540E-01
0.625	241.	7.5712E-01
0.675	240.	7.5398E-01
0.725	219.	6.8801E-01
0.775	165.	5.1836E-01
0.825	150.	4.7124E-01
0.875	154.	4.8381E-01
0.925	129.	4.0527E-01
0.975	76.	2.3876E-01
1.025	70.	2.1991E-01
1.075	47.	1.4765E-01
1.125	36.	1.1310E-01
1.175	25.	7.8540E-02
1.225	17.	5.3407E-02
1.275	5.	1.5708E-02
1.325	7.	2.1991E-02
1.375	9.	2.8274E-02
1.425	2.	6.2832E-03
1.475	1.	3.1416E-03
1.525	1.	3.1416E-03
TØTAL	10000.	

M0	M1	M2	M3	M4
1.5708E 00	-2.8584E-03	4.6769E-01	-2.6658E-03	3.0916E-01

DELTAE = 0.050   EIGENVALUES(1), (5)

EIGENVALUES NØRMALIZED BY 2*WFB*SQRTF(N) = 4.4721E 00

E MIDPT	CØUNT	P-BAR
0.025	1.	5.0000E-03
0.075	1.	5.0000E-03
0.125	3.	1.5000E-02
0.175	11.	5.5000E-02
0.225	19.	9.5000E-02
0.275	50.	2.5000E-01
0.325	66.	3.3000E-01
0.375	114.	5.7000E-01
0.425	143.	7.1500E-01
0.475	199.	9.9500E-01
0.525	233.	1.1650E 00
0.575	317.	1.5850E 00
0.625	323.	1.6150E 00
0.675	359.	1.7950E 00
0.725	377.	1.8850E 00
0.775	330.	1.6500E 00
0.825	316.	1.5800E 00
0.875	278.	1.3900E 00
0.925	266.	1.3300E 00
0.975	167.	8.3500E-01
1.025	134.	6.7000E-01
1.075	95.	4.7500E-01
1.125	65.	3.2500E-01
1.175	49.	2.4500E-01
1.225	33.	1.6500E-01
1.275	15.	7.5000E-02
1.325	15.	7.5000E-02
1.375	11.	5.5000E-02
1.425	4.	2.0000E-02
1.475	3.	1.5000E-02
1.525	2.	1.0000E-02
1.575	1.	5.0000E-03
TØTAL	4000.	

M0	M1	M2	M3	M4
10.0000E-01	7.2752E-01	5.7789E-01	4.9330E-01	4.4799E-01

DELTAE = 0.050 EIGENVALUES(2), (4)

EIGENVALUES NØRMALIZED BY 2*WFB*SQRTF(N) = 4.4721E 00

E MIDPT	CØUNT	P-BAR
0.025	227.	1.1350E 00
0.075	200.	1.0000E 00
0.125	244.	1.2200E 00
0.175	311.	1.5550E 00
0.225	360.	1.8000E 00
0.275	387.	1.9350E 00
0.325	413.	2.0650E 00
0.375	415.	2.0750E 00
0.425	355.	1.7750E 00
0.475	309.	1.5450E 00
0.525	239.	1.1950E 00
0.575	174.	8.7000E-01
0.625	147.	7.3500E-01
0.675	103.	5.1500E-01
0.725	55.	2.7500E-01
0.775	32.	1.6000E-01
0.825	13.	6.5000E-02
0.875	11.	5.5000E-02
0.925	2.	1.0000E-02
0.975	1.	5.0000E-03
1.025	2.	1.0000E-02
TØTAL	4000.	

M0	M1	M2	M3	M4
10.0000E-01	3.3934E-01	1.4896E-01	7.5307E-02	4.2099E-02

DELTAE = 0.050 EIGENVALUES(3), (3)

EIGENVALUES NØRMALIZED BY 2*WFB*SQRTF(N) = 4.4721E 00

E MIDPT	CØUNT	P-BAR
0.025	422.	4.2200E 00
0.075	414.	4.1400E 00
0.125	343.	3.4300E 00
0.175	276.	2.7600E 00
0.225	204.	2.0400E 00
0.275	138.	1.3800E 00
0.325	88.	8.8000E-01
0.375	49.	4.9000E-01
0.425	30.	3.0000E-01
0.475	18.	1.8000E-01
0.525	8.	8.0000E-02
0.575	5.	5.0000E-02
0.625	4.	4.0000E-02
0.675	0.	0.
0.725	0.	0.
0.775	0.	0.
0.825	1.	1.0000E-02
TØTAL	2000.	

M0	M1	M2	M3	M4
10.0000E-01	1.4765E-01	3.4467E-02	1.0504E-02	3.8709E-03

DELTAA = 0.050 EIGENVECTØR CØMPØNENTS

A MIDPT	CØUNT	P-BAR
0.025	3733.	1.4932E 00
0.075	3653.	1.4612E 00
0.125	3591.	1.4364E 00
0.175	3740.	1.4960E 00
0.225	3551.	1.4204E 00
0.275	3535.	1.4140E 00
0.325	3290.	1.3160E 00
0.375	3249.	1.2996E 00
0.425	3050.	1.2200E 00
0.475	2942.	1.1768E 00
0.525	2759.	1.1036E 00
0.575	2562.	1.0248E 00
0.625	2315.	9.2600E-01
0.675	1991.	7.9640E-01
0.725	1774.	7.0960E-01
0.775	1471.	5.8840E-01
0.825	1256.	5.0240E-01
0.875	825.	3.3000E-01
0.925	533.	2.1320E-01
0.975	180.	7.2000E-02
TØTAL	50000.	

M0	M1	M2	M3	M4
10.0000E-01	3.7577E-01	2.0017E-01	1.2495E-01	8.5587E-02

DELTAA = 0.050 EIGENVECTØRS(1), (5)

A MIDPT	CØUNT	P-BAR
0.025	1543.	1.5430E 00
0.075	1422.	1.4220E 00
0.125	1432.	1.4320E 00
0.175	1480.	1.4800E 00
0.225	1391.	1.3910E 00
0.275	1397.	1.3970E 00
0.325	1318.	1.3180E 00
0.375	1357.	1.3570E 00
0.425	1235.	1.2350E 00
0.475	1144.	1.1440E 00
0.525	1093.	1.0930E 00
0.575	1064.	1.0640E 00
0.625	927.	9.2700E-01
0.675	791.	7.9100E-01
0.725	718.	7.1800E-01
0.775	583.	5.8300E-01
0.825	486.	4.8600E-01
0.875	339.	3.3900E-01
0.925	211.	2.1100E-01
0.975	69.	6.9000E-02
TØTAL	20000.	

M0	M1	M2	M3	M4
10.0000E-01	3.7586E-01	2.0018E-01	1.2482E-01	8.5389E-02

DELTAA = 0.050 EIGENVECTØRS(2), (4)

A MIDPT	CØUNT	P-BAR
0.025	1443.	1.4430E 00
0.075	1485.	1.4850E 00
0.125	1460.	1.4600E 00
0.175	1488.	1.4880E 00
0.225	1463.	1.4630E 00
0.275	1423.	1.4230E 00
0.325	1324.	1.3240E 00
0.375	1255.	1.2550E 00
0.425	1201.	1.2010E 00
0.475	1199.	1.1990E 00
0.525	1113.	1.1130E 00
0.575	1005.	1.0050E 00
0.625	934.	9.3400E-01
0.675	790.	7.9000E-01
0.725	711.	7.1100E-01
0.775	572.	5.7200E-01
0.825	512.	5.1200E-01
0.875	328.	3.2800E-01
0.925	219.	2.1900E-01
0.975	75.	7.5000E-02
TØTAL	20000.	

M0	M1	M2	M3	M4
10.0000E-01	3.7574E-01	2.0012E-01	1.2502E-01	8.5738E-02

DELTAA = 0.050 EIGENVECTØRS(3), (3)

A MIDPT	CØUNT	P-BAR
0.025	747.	1.4940E 00
0.075	746.	1.4920E 00
0.125	699.	1.3980E 00
0.175	772.	1.5440E 00
0.225	697.	1.3940E 00
0.275	715.	1.4300E 00
0.325	648.	1.2960E 00
0.375	637.	1.2740E 00
0.425	614.	1.2280E 00
0.475	599.	1.1980E 00
0.525	553.	1.1060E 00
0.575	493.	9.8600E-01
0.625	454.	9.0800E-01
0.675	410.	8.2000E-01
0.725	345.	6.9000E-01
0.775	316.	6.3200E-01
0.825	258.	5.1600E-01
0.875	158.	3.1600E-01
0.925	103.	2.0600E-01
0.975	36.	7.2000E-02
TØTAL	10000.	

M0	M1	M2	M3	M4
10.0000E-01	3.7563E-01	2.0023E-01	1.2507E-01	8.5682E-02