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ABSTRACT

Described and listed herein with concomitant sample input and output is the Fortran IV program which estimates parameters and standard errors of estimate per parameters for parameters estimated through multiple matrix sampling. The specific program is an improved and expanded version of an earlier version. (Author/BJG)

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DATE: May 30, 1972

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TITLE: A FORTRAN IV PROGRAM FOR ESTIMATING PARAMETERS THROUGH MULTIPLE MATRIX SAMPLING WITH STANDARD ERRORS OF ESTIMATE APPROXIMATED BY THE JACKKNIFE

AUTHOR: David M. Shoemaker

ABSTRACT

Described and listed herein with concomitant sample input and output is the Fortran IV program which estimates parameters and standard errors of estimate per parameters for parameters estimated through multiple matrix sampling. The specific program is an improved and expanded version of an earlier version given in an appendix of Technical Report No. 34.

PROGRAM FOR ESTIMATING PARAMETERS THROUGH MULTIPLE MATRIX SAMPLING WITH STANDARD ERRORS OF ESTIMATE APPROXIMATED BY THE JACKKNIFE

1.0 - PROGRAM IDENTIFICATION

Program for Estimating Parameters through Multiple Matrix Sampling with Standard Errors of Estimate Approximated by the Jackknife*

2.0 - OBJECTIVE

This program estimates selected parameters and standard error of estimate associated with each parameter given multiple matrix sampling.

3.0 - PROGRAM DESCRIPTION

Using item scores sequenced by subtest and, within each subtest, by examinee as input, the program computes an estimate of each parameter for each subtest and then pools results over subtests to provide the best estimate of each parameter. The parameters estimated within the program are: (a) mean test score, (b) second central moment, (c) third central moment, (d) fourth central moment, (e) component of variance for items, (f) component of variance for examinees, (g) component of variance for item x examinee interaction, (h) average item reliability, (i) item difficulty for each item tested, and (j) reliability of the total score. The equations used to estimate parameters (a) through (d) are those given by Lord (1960); the equations for estimating components of variance for a completely randomized two-factor design are given in numerous sources (e.g., Myers, 1966); and the equation for estimating the average item reliability is given by Winer (1971). A pooled (over subtests) estimate of each parameter as well as the estimated standard error of estimate associated with each parameter is accomplished by the jackknife procedure. A description of the jackknife procedure and research supporting its use in multiple matrix sampling is given by Shoemaker (1972). The 90, 95, 97.5 and 99 percent confidence intervals for parameters (a) through (h) are computed using the *t*-distribution (df = number of subtests minus one) and jackknifed standard errors of estimate. The reliability of the total test score is computed by projecting the pooled average item reliability to the total test using the Spearman-Brown prophesy formula. Using pooled estimates of moments, the normative relative frequency distribution is graduated by the negative hypergeometric distribution and/or one of the family

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* This program is an improved and expanded version of an earlier version given in an appendix of Technical Report No. 34 and abstracted in Behavioral Science (Shoemaker, D. M. A Fortran IV program for approximating a normative distribution with the negative hypergeometric distribution. Behavioral Science, 1971, 16, 414-415.)

of Pearson curves as opted by the user. The equation for the negative hypergeometric distribution is given by Lord and Novick (1968) and the equations for the Pearson curves are given by Elderton and Johnson (1969).

4.0 - SUBROUTINES AND FUNCTIONS

4.1 - Coded Subprograms

LOAD - Duplication of data base on scratch file number 2. No arguments.

NEGHGR - Graduation of normative distribution by negative hypergeometric distribution.

SUBROUTINE NEGHGR (KPOP, XBAR, XVAR)

KPOP - Maximum test score
XBAR - Mean test score
XVAR - Variance of test scores

TTABLE - Calculation of Student's t corresponding to prescribed alpha level (two-tailed probability).

SUBROUTINE TTABLE (T,N,AREA)

T - Student's t.
N - Degrees of freedom associated with t.
AREA - Relative area associated with confidence interval.

RDFMT - Subroutine for inputting variable format.

SUBROUTINE RDFMT (FMT,N)

FMT - Vector containing format.
N - Number of format cards inputted.

JKNIFE - Calculation of pooled estimates of parameters and associated standard error of estimate per parameter by the jackknife procedure.

SUBROUTINE JKNIFE (U1,U2,U3,U4)

U1 - Pooled estimate of mean test score.
U2 - Pooled estimate of second central moment.
U3 - Pooled estimate of third central moment.
U4 - Pooled estimate of fourth central moment.

SUBTST - Calculation of parameter estimates for each subtest.

SUBROUTINE SUBTST (NDICH,KPOP,NDISK)

NDICH - Item scoring procedure.
- 0 = dichotomous
- 1 = non-dichotomous

KPOP - Maximum test score.

NDISK - Data base storage.
- 0 = no storage on scratch file
- 1 = data base stored on scratch file

PEARSN - Graduation of normative distribution with one of the family of Pearson curves.

SUBROUTINE PEARSN (U1,U2,U3,U4,L1,L2,STEP)

U1 - Mean test score.
U2 - Second central moment.
U3 - Third central moment.
U4 - Fourth central moment.
L1 - Lower limite of index.
L2 - Upper limit of index.
STEP - Desired step size in going from L1 to L2.

POLRT - Computation of the real and complex roots of a real polynomial.

SUBROUTINE POLRT (XCOF,M,ROOTR,ROOTI,IER)

XCOF - Vector of M + 1 coefficients of the polynomial ordered from smallest to largest power.

M - Order of polynomial.

ROOTR - Resultant vector of length M containing real roots.

ROOTI - Resultant vector of length M containing the corresponding imaginary roots.

IER - Error code return.
- 0 = no error
- 1 = M less than 1
- 2 = M greater than 36
- 3 = unable to determine root with 500 iterations on 5 starting values
- 4 = high order coefficient is zero

FRV - Evaluation of $\cos(x)^r e^{-vx} dx$ from -1.570796 to 1.570796 using Simpson's rule.

```
FUNCTION FRV (R,VV)

    R - 6.*(B2-B1-1.)/(2.*B2-3.*B1-6.)
    VV - SQRT((R*R*(R-2.)**2*B1)/(16.*(R-1.)-B1*(R-2.)**2))
```

GAMMA - Computation of gamma function using the recursion relation and polynomial approximation.

```
FUNCTION GAMMA (XX)

    XX - Any real argument.
```

4.2 - Library Subprograms

ALOG10	ABS
ALOG	
SQRT	
ATAN	
COS	
EXP	

5.0 - DATA SPECIFICATIONS

5.1 - Input Formats

Input formats are described in detail at the beginning of the program listing. An example of an input data structure is given in Attachment 1.

5.2 - Output Formats

Output resulting from the input data structure listed in Attachment 1 is given in Attachment 2.

6.0 - PROGRAM CONSTRAINTS AND LIMITATIONS

6.1 - Programming Language

FORTRAN IV

6.2 - Vendor

University of California at Los Angeles Campus Computing Network

6.3 - Storage Requirements

Total core for execution: 150K
See 7.0 for scratch file requirements.

6.4 - Hardware Configuration

IBM 360 Model 91, Punched cards

6.5 - Program Parameters

6.5.1 - Item scoring: the statistical procedures used within the program assume a uniform scoring procedure for all items in all subtests.

6.5.2 - Parameters estimated: although the program is designed primarily to estimate parameters when items are scored dichotomously (0 = fail, 1 = pass), selected parameters are estimated when items are not scored dichotomously--specifically, all parameters with the exception of the third and fourth central moments. This is a limitation because without estimates of these moments it is not possible to graduate the normative distribution. Equations for the third and fourth central moments when items are scored non-dichotomously are under development currently and will be included in the next revision of the program. This limitation in the current program is relatively minor because scoring items non-dichotomously is a procedure encountered rarely in practice.

6.5.3 - The number of subtests within any data structure is limited to 100.

6.5.4 - The number of items per subtest is limited to 150.

6.6 - Error Messages

The following error messages may be generated by the program:

1. Errors on card specifying problem set (MAIN)
(Note: error terminates program)

2. Error in t-table arg: df = __ (TTABLE)

3. Error in t-table arg: p = __ (TTABLE)

4. Excessive number of format cards (RDFMT)
(Note: error terminates program)

5. Invalid limits and/or delta arguments (PEARSN)

6. Ordinate undefined at this point (PEARSN)

7. M .LE. 1. for Type XI (PEARSN)

8. M out of range for Type VIII (PEARSN)

9. M negative for Type IX (PEARSN)

10. Gamma arg within .0000001 of being a negative integer (GAMMA)

11. Gamma arg GT 57, overflow, ans set to 1.E75 (GAMMA)

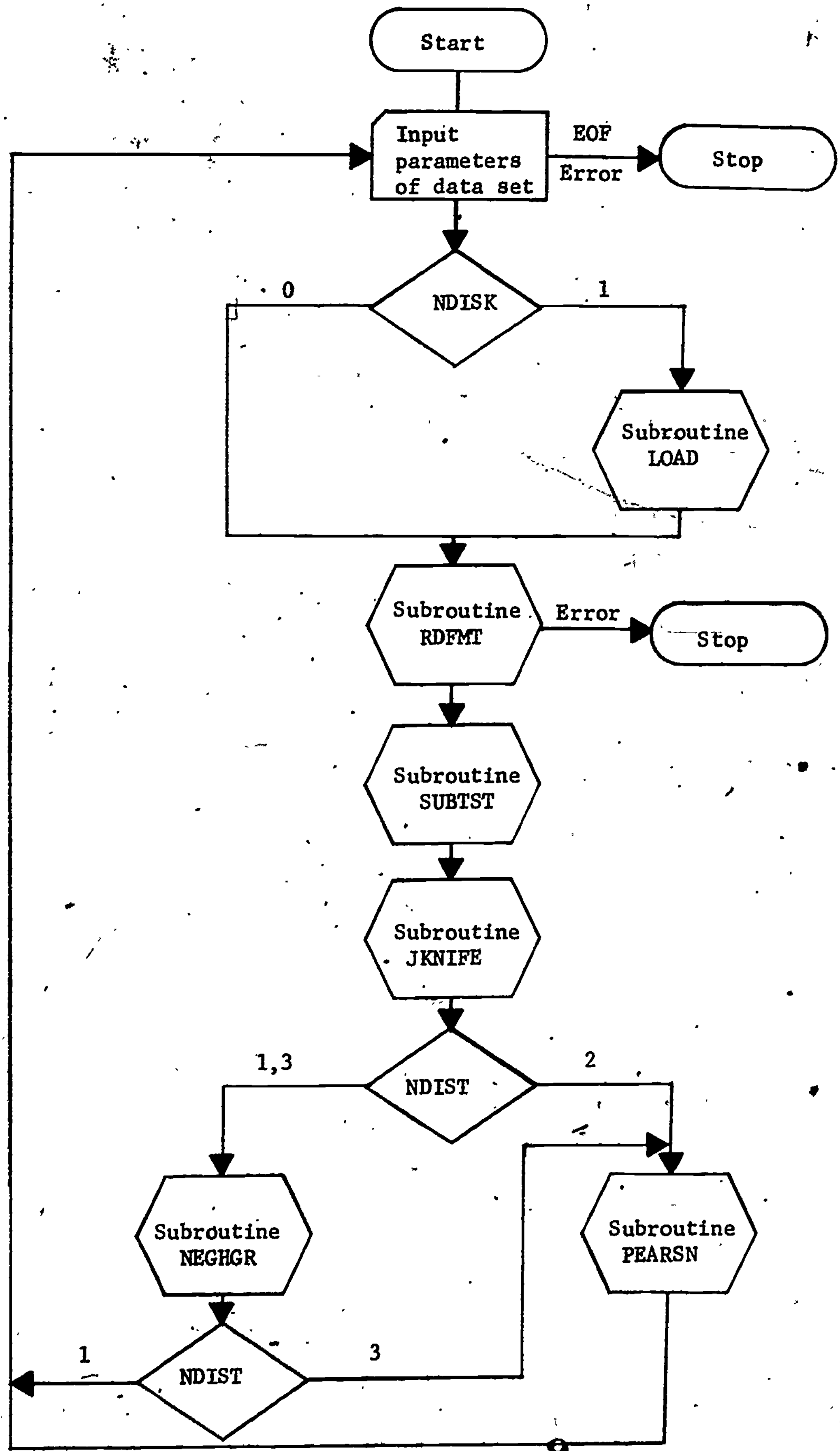
7.0 - OPERATING INSTRUCTIONS

Submit the program in batch mode in the following form:

col 1

```
//job card
// PASSWORD
// EXEC FORTGCLG,RG=150K
//FORT.SYSIN DD *
  main
  subroutines
/*
//GO.FT02F001 DD DSN=&SCRATCH,UNIT=SYSDA,
// DCB=(RECFM=FBA,BLKSIZE=7280,LRECL=80),SPACE=(TRK,150,RLSE)
//GO.SYSIN DD *
  data structures
/*
//
```

8.0 - PROGRAM FLOWCHART



9.0 - PROGRAM LISTING

```
C
C*****************************************************************************************
C
C
C  ESTIMATION OF TEST SCORE PARAMETERS THROUGH MULTIPLE MATRIX SAMPLING
C  WITH STANDARD ERRORS OF ESTIMATE APPROXIMATED BY THE JACKKNIFE
C  PROCEDURE
C
C
C  DAVID M. SHOEMAKER
C  SOUTHWEST REGIONAL LABORATORY FOR EDUCATIONAL
C     RESEARCH AND DEVELOPMENT
C
C
C  ORGANIZATION OF DATA STRUCTURES
C
C     1.  DATA CARDS ARE ORGANIZED SEQUENTIALLY INTO PROBLEM SETS.  EACH
C         PROBLEM SET CONTAINS (IN THIS ORDER) THE FOLLOWING CARD SETS:
C
C           TITLE CARD
C           PARAMETER CARD
C           DATA BLOCK FOR SUBTEST 1
C           DATA BLOCK FOR SUBTEST 2
C           ...
C           DATA BLOCK FOR SUBTEST T
C
C
C     2.  ORGANIZATION OF INDIVIDUAL CARD SETS:
C
C
C             CARD SET                     COLUMN     DESCRIPTION
C                                                     (INTEGERS RIGHT-JUSTIFIED)
C             -------------------          ------     -------------------------
C
C         A.  TITLE CARD (1 CARD)          01-72      ALPHANUMERIC TITLE OF
C                                                     PROBLEM SET
C
C         B.  PARAMETER CARD (1 CARD)      01-04      MAXIMUM INTEGER TEST
C                                                     SCORE
C
C                                          05-08      NUMBER OF SUBTESTS
C
C                                            10       METHOD OF ITEM SCORING
C
C                                                           0=DICHOTOMOUS
C                                                           1=NON-DICHOTOMOUS
C
C                                            12       NORMATIVE DISTRIBUTION
C
C                                                           0=NONE DESIRED
C                                                           1=NEG.HYPER.
C                                                           2=PEARSON CURVE
C                                                           3=BOTH 1 AND 2
C
```

16-30	MEAN
31-45	VARIANCE
46-60	3RD CENTRAL MOMENT
61-75	4TH CENTRAL MOMENT

NOTE: THIS PROGRAM MAY ALSO BE USED TO GRADUATE NORMATIVE DISTRIBUTIONS WITH THE NECESSARY MOMENTS CALCULATED IN ADVANCE. IN THIS CASE, THE REQUIRED MOMENTS ARE INPUTTED ON COLUMNS 16 TO 75 (WITH DECIMAL POINT PUNCHED ON THE CARD). THE NUMBER OF SUBTESTS (COLUMNS 5 TO 8) SHOULD BE SET EQUAL TO 0. IF ESTIMATES OF PARAMETERS ARE TO BE COMPUTED THROUGH MULTIPLE MATRIX SAMPLING, IGNORE COLUMNS 16 THROUGH 75.

C. DATA BLOCK FOR SUBTEST I: THE DATA BLOCK FOR EACH SUBTEST CONSISTS OF THREE CARD SETS.

1) PARAMETER CARD (1 CARD)
2) FORMAT CARD SET (K CARDS)
3) DATA CARDS CONTAINING ITEM SCORES PER EXAMINEE SEQUENCED BY EXAMINEE

THE ORGANIZATION OF THESE CARD SETS IS AS FOLLOWS:

PARAMETER CARD	01-04	NUMBER OF EXAMINEES IN SUBGROUP
	05-08	NUMBER OF ITEMS PER SUBGROUP
FORMAT CARD SET	01-72	STANDARD FORTRAN IV FORMAT PUNCHED IN COLUMNS 01-72 ON EACH CARD AND ENCLOSED IN PARENTHESES FOR INPUTTING ITEM SCORES FOR EACH EXAMINEE IN THE ITEM-EXAMINEE SAMPLE. THE NUMBER OF CARDS CONTAINING THE FORMAT MAY NOT EXCEED NINE FOR EACH ITEM-EXAMINEE DATA SET. THE FIRST CARD AFTER THE FORMAT CARDS MUST CONTAIN "END OF FORMAT" IN COLUMNS 01-13.
DATA CARD SET		THE ITEM SCORES OF EACH EXAMINEE ON SUBTEST SEQUENCED BY EXAMINEE AND ORGANIZED ON CARDS ACCORDING TO FORMAT SPECIFICATION

```
C
C     3.  THE PROGRAM WILL PROCESS REPEATED PROBLEM SETS.
C
C     4.  RESTRICTIONS:
C
C         A.  NUMBER OF SUBTESTS LIMITED TO 100
C         B.  NUMBER OF ITEMS PER SUBTEST LIMITED TO 150
C         C.  WHEN ITEMS ARE SCORED NON-DICHOTOMOUSLY, ONLY THE MEAN TEST
C             SCORE, VARIANCE OF TEST SCORES, VARIANCE OF THE ITEM
C             DIFFICULTY INDICES AND TEST RELIABILITY ARE ESTIMATED.
C         D.  WHEN ITEMS ARE SCORED DICHOTOMOUSLY, THE MEAN TEST SCORE,
C             VARIANCE OF TEST SCORES, 3RD AND 4TH CENTRAL TEST SCORE
C             MOMENTS, VARIANCE OF ITEM DIFFICULTY INDICES AND TEST
C             RELIABILITY ARE ESTIMATED.
C
C
C     5.  IT IS FREQUENTLY THE CASE THAT THE INVESTIGATOR WISHES TO
C         ASSEMBLE ITEM SCORES INTO CONTENT STRATA AND TO PROCESS THE
C         ITEMS WITHIN EACH CONTENT STRATUM AS THOUGH THEY WERE ITEM
C         POPULATIONS PER SE.  CONSIDER, FOR EXAMPLE, THE CASE IN WHICH
C         HALF THE ITEMS IN EACH SUBTEST MEASURE OUTCOME CASE A WITH THE
C         OTHER HALF MEASURING OUTCOME CASE B.  HERE, THE INVESTIGATOR
C         MAY WANT TO ANALYZE RESULTS SEPARATELY FOR A AND B.  THIS
C         COULD BE HANDLED THROUGH DATA STRUCTURES 1. AND 2. BUT TWO
C         DUPLICATE SETS OF ITEM SCORES WOULD BE REQUIRED.  TO AVOID
C         USING DUPLICATE SETS OF ITEM SCORES, IT IS POSSIBLE WITHIN
C         THE PROGRAM TO STORE A DATA SET ON A SCRATCH FILE AND THEN
C         MAKE REPEATED PASSES THROUGH IT USING DIFFERENT FORMAT CARDS
C         (OF THE TYPE DESCRIBED IN 2C).
C
C
C         THE ORGANIZATION OF INPUT CARDS FOR THIS CAPABILITY IS ONLY
C         SLIGHTLY DIFFERENT FROM THE STANDARD CARD ORGANIZATION.  ASSUME,
C         FOR EXAMPLE, THAT THERE ARE 5 PROBLEM SETS EACH OF WHICH IS TO
C         USE THE SAME DATA BASE.  WITHIN THE DATA STREAM, THIS DATA BASE
C         PRECEEDS THE PROBLEM SETS.  THE DATA BASE MUST BE PRECEEDED BY
C         A CARD WITH "STR2" PUNCHED IN COLUMNS 1 THROUGH 4 AND TERMINATED
C         BY A CARD WHICH HAS "END" PUNCHED IN COLUMNS 1 THROUGH 3.
C         EACH PROBLEM SET WHICH IS TO USE THIS DATA BASE MUST HAVE A
C         "1" PUNCHED IN COLUMN 14 OF CARD 2B.  WHEN THIS OPTION IS USED,
C         THE "DATA CARD SET" DESCRIBED IN 2C IS OMITTED.  EVERYTHING
C         ELSE STAYS THE SAME.
C
C             A.  PROBLEM SETS USING THIS STORAGE FEATURE MAY BE
C                 INTERSPERSED AMONG STANDARD PROBLEM SETS.
C
C             B.  A CALL TO STORE A DATA BASE MAY BE INSERTED AT ANY
C                 PLACE (PRECEEDING A PROBLEM SET) WITHIN THE DATA STREAM.
C                 A DATA BASE MAY BE STORED ANY NUMBER OF TIMES, BUT
C                 ONLY ONE BASE IS IN STORAGE AT ANY PARTICULAR TIME.
C
C             C.  SCRATCH FILE 2 IS USED WITHIN THE PROGRAM.  THE
C                 STORAGE CAPACITY OF THIS FILE IS 13,650 CARD IMAGES.
C                 IF MORE STORAGE SPACE IS NEEDED, AN ADDITIONAL FILE
```

```
C                   MUST BE USED.
C
C
C*******************************************************************************
C
      COMMON /BLOCK1/ SDATA(102,11),NTEST
      DATA STR2/4HSTR2/
      DIMENSION TITLE(18)
C
C  READ SPECIFICATIONS FOR PROBLEM SET
C
 1000 READ (5,1,END=5000) (TITLE(I),I=1,18)
      IF ( TITLE(1) .NE. STR2 ) GO TO 50
      CALL LOAD
      GO TO 1000
 50   READ (5,7) KPOP,NTEST,NDICH,NDIST,NDISK,U1,U2,U3,U4
      IF ( NDISK .EQ. 1 ) REWIND 2
C
      WRITE (6,2) (TITLE(I),I=1,18)
      IF ( U1 .LE. 0. ) WRITE (6,3) KPOP,NTEST,NDICH,NDIST
      IF ( U1 .GT. 0. ) WRITE (6,4) KPOP,NDIST,U1,U2,U3,U4
C
C  CHECK ON PARAMETERS
C
      NERR=0
      IF ( NDICH .LT. 0 .OR. NDICH .GT. 1 ) NERR=NERR+1
      IF ( NDIST .LT. 0 .OR. NDIST .GT. 3 ) NERR=NERR+1
      IF ( KPOP .LE. 0 ) NERR=NERR+1
      IF ( U1 .NE. 0. .AND. NTEST .GT. 0 ) NERR=NERR+1
      IF ( NERR .LE. 0 ) GO TO 90
      WRITE (6,5) NERR
      CALL EXIT
 90   CONTINUE
C
C  BYPASS ESTIMATION PROCEDURE IF MOMENTS ARE AVAILABLE
C
      IF ( U1 .GT. 0. ) GO TO 100
C
C  ESTIMATE PARAMETERS FROM SUBTEST RESULTS
C
      CALL SUBTST(NDICH,KPOP,NDISK)
C
C  COMPUTE POOLED ESTIMATE (OVER SUBTESTS) OF PARAMETER AND STANDARD
C  ERROR OF ESTIMATE ASSOCIATED WITH PARAMETER THROUGH JACKKNIFE PROCEDURE
C
      CALL JKNIFE(U1,U2,U3,U4)
C
C  ESTIMATION OF RELIABILITY OF TOTAL TEST SCORE ON KPOP-ITEM TEST
C
      THETA=SDATA(101,8)
      RTT=KPOP*THETA/(1.+KPOP*THETA)
      WRITE (6,8) RTT
C
C  GRADUATE NORMATIVE DISTRIBUTION
```

```
C
 100  IF ( NDIST .EQ. 0 ) GO TO 1000
      IF ( NDICH .EQ. 1 ) GO TO 1000
      S=KPOP
      GO TO (110,120,110), NDIST
 110  CALL NEGHGR (KPOP,U1,U2)
      IF ( NDIST .LT. 3 ) GO TO 1000
 120  CALL PEARSN (U1,U2,U3,U4,0.,S,1.)
      GO TO 1000
C
C  EXIT GRACEFULLY
C
 5000 WRITE (6,6)
      CALL EXIT
C
C  FORMAT STATEMENTS
C
 1    FORMAT (18A4)
 2    FORMAT (1H1,18A4//)
 3    FORMAT (31H SPECIFICATIONS FOR PROBLEM SET//
     119H MAXIMUM TEST SCOREI11/
     219H NUMBER OF SUBTESTSI11/
     313H ITEM SCORINGI17/
     423H NORMATIVE DISTRIBUTIONI7)
 4    FORMAT (31H SPECIFICATIONS FOR PROBLEM SET//
     119H MAXIMUM TEST SCOREI11/
     223H NORMATIVE DISTRIBUTIONI7/
     34H U1 F15.5/3H U2F16.5/3H U3F16.5/3H U4F16.5)
 5    FORMAT (4H ***I3,38H ERRORS ON CARD SPECIFYING PROBLEM SET//)
 6    FORMAT (20H ALL INPUT PROCESSED)
 7    FORMAT (2I4,3I2,1X,4F15.0)
 8    FORMAT (//45H ESTIMATED RELIABILITY OF TOTAL TEST SCORE ISF8.5//)
      END
```

```
      SUBROUTINE LOAD
C
C  DUPLICATION OF DATA BASE ON SCRATCH FILE NUMBER 2
C
      DIMENSION X(20)
      DATA END/3HEND/
      REWIND 2
      WRITE (6,2)
100   READ (5,1) (X(I),I=1,20)
      WRITE (6,3) (X(I),I=1,20)
      IF ( X(1) .EQ. END ) GO TO 200
      WRITE (2,1) (X(I),I=1,20)
      GO TO 100
200   END FILE 2
      RETURN
1     FORMAT (20A4)
2     FORMAT (//37H1CARD IMAGES LOADED ON SCRATCH FILE 2//)
3     FORMAT (1X,20A4)
      END
```

```
      SUBROUTINE NEGHGR (KPOP,XBAR,XVAR)
C
C  GRADUATION OF NORMATIVE DISTRIBUTION BY NEGATIVE HYPERGEOMETRIC
C  DISTRIBUTION
C
C  COMPUTATION OF CONSTANTS
C
      A21=(KPOP/(KPOP-1.))*(1.-XBAR*(KPOP-XBAR)/(KPOP*XVAR))
      WRITE (6,1) XBAR,XVAR,A21
      IF ( A21 .GT. 0. .AND. A21 .LT. 1. ) GO TO 120
      WRITE (6,2)
      RETURN
120   A=(-1.+1./A21)*XBAR
      B=-A-1.+KPOP/A21
      SLOG1=0.
      SLOG2=0.
      C=A+B
      DO 140 I=1,KPOP
      SLOG1=SLOG1+ALOG10(B-I+1.)
140   SLOG2=SLOG2+ALOG10(C-I+1.)
      C=10.**(SLOG1-SLOG2)
C
C  GENERATION OF NEGATIVE HYPERGEOMETRIC DISTRIBUTION
C
      WRITE (6,3)
      S=KPOP
      N3=KPOP+1
```

```
      CK=0.
      DO 200 J=1,N3
      K=J-1
      IF ( K .EQ. 0 ) GO TO 160
      SLOG1=0.
      SLOG2=0.
      SLOG3=0.
      SLOG4=0.
      DO 150 I=1,K
      SLOG1=SLOG1+ALOG10(S-I+1.)
      SLOG2=SLOG2+ALOG10(A+I-1.)
      SLOG3=SLOG3+ALOG10(B-I+1.)
  150 SLOG4=SLOG4+ALOG10(FLOAT(I))
      HX=C*10.**(SLOG1+SLOG2-SLOG3-SLOG4)
      GO TO 165
  160 HX=C
  165 CK=CK+HX
      WRITE (6,4) K,HX,CK
  200 CONTINUE
C
      RETURN
C
    1 FORMAT (//82H APPROXIMATION OF NORMATIVE DISTRIBUTION WITH NEGATIV
     1E HYPERGEOMETRIC DISTRIBUTION//21H ESTIMATED PARAMETERS//5H MEAN,
     2F25.5/9H VARIANCEF21.5/4H A21F26.5)
    2 FORMAT (//30H DISTRIBUTION ABORTED A21 LE 0//)
    3 FORMAT (//5X,5HINDEX,5X,13HRELATIVE FREQ,10X,12HCUM REL FREQ//)
    4 FORMAT (1X,I9,F18.5,F22.5)
      END
```

```
      SUBROUTINE TTABLE (T,N,AREA)
C
C   CALCULATION OF STUDENT'S T CORRESPONDING TO PRESCRIBED ALPHA LEVEL
C   (TWO-TAILED PROBABILITY)
C
C      ARGUMENTS
C
C         T = STUDENT'S T
C         N = DEGREES OF FREEDOM ASSOCIATED WITH T
C      AREA = RELATIVE AREA ASSOCIATED WITH CONFIDENCE INTERVAL
C
C   POLYNOMIAL APPROXIMATIONS USED FOR BOTH T AND Z
C
C   REFERENCE:  ABRAMOWITZ, M. & STEGUM, I. A. HANDBOOK OF MATHEMATICAL
C               FUNCTIONS. NATIONAL BUREAU OF STANDARDS APPLIED
C               MATHEMATICS SERIES NO. 55, 1964.
C               (SEE 26.2.23 AND 26.7.5)
C
      IF ( N .GT. 0 ) GO TO 100
      WRITE (6,1) N
      GO TO 150
 100  P=(1.-AREA)/2.
      IF ( P .GT. 0. .AND. P .LE. .5 ) GO TO 200
      WRITE (6,2) P
 150  T=0.
      RETURN
 200  X=SQRT(ALOG(1./(P*P)))
C
      Z=X-(2.515517+.802853*X+.010328*X*X)/
     1     (1.+1.432788*X+.189269*X*X+.001308*X**3)
C
      Z3=Z**3
      Z5=Z**5
      Z7=Z**7
      Z9=Z**9
      G1=(Z3+Z)/4.
      G2=(5.*Z5+16.*Z3+3.*Z)/96.
      G3=(3.*Z7+19.*Z5+17.*Z3-15.*Z)/384.
      G4=(79.*Z9+776.*Z7+1482.*Z5-1920.*Z3-945.*Z)/92160.
C
      T=Z+G1/N+G2/N**2+G3/N**3+G4/N**4
C
      RETURN
    1 FORMAT (//27H ERROR IN T-TABLE ARG: DF =I12//)
    2 FORMAT (//26H ERROR IN T-TABLE ARG: P =E15.5//)
      END
```

```
      SUBROUTINE RDFMT (FMT,N)
C
C   SUBROUTINE FOR INPUTTING VARIABLE FORMAT
C
C   INPUT STRUCTURE
C
C           FORMAT (ENCLOSED IN PARENTHESES) COLUMNS 01-72
C              CONTINUE ON CARD 2 IF NECESSARY
C              CONTINUE ON CARD 3 IF NECESSARY
C              ...
C              CONTINUE TO CARD 9 (MAX) IF NECESSARY
C           "END OF FORMAT" PUNCHED IN COLUMNS 01-13
C
      DIMENSION FMT(162)
      DATA END,BLK/3HEND,1H /
      DO 50 I=1,162
 50   FMT(I)=BLK
      N=1
      DO 100 I=1,10
      M=N+17
      READ (5,1) (FMT(J),J=N,M)
      IF ( FMT(N) .EQ. END ) RETURN
 100  N=N+18
      WRITE (6,2)
      STOP
 1    FORMAT (18A4)
 2    FORMAT (37H *** EXCESSIVE NUMBER OF FORMAT CARDS)
      END
```

```
      FUNCTION FRV (R,VV)
C
C   EVALUATION OF COS(X)**R*EXP(-V*X)DX FROM -PI/2 TO PI/2 USING
C   SIMPSON'S RULE
C
      V=ABS(VV)
      PI=3.141593
      D=PI/100.
      FRV=0.
      DO 100 I=1,99,2
      T=-1.570796+I*D
 100  FRV=FRV+2.*COS(T)**R*EXP(-V*T)+COS(T+D)**R*EXP(-VT-VD)
      FRV=2.*D*FRV/3.
      RETURN
      END
```

```
      FUNCTION GAMMA (XX)
C
C  COMPUTATION OF GAMMA FUNCTION USING THE RECURSION RELATION AND
C  POLYNOMIAL APPROXIMATION
C
      IF ( XX-57. ) 6,6,4
 4    WRITE (6,2)
      GAMMA=1.E75
      RETURN
 6    X=XX
      ERR=1.E-6
      GX=1.
      IF ( X-2. ) 50,50,15
 10   IF ( X-2. ) 110,110,15
 15   X=X-1.
      GX=GX*X
      GO TO 10
 50   IF ( X-1. ) 60,120,110
C
C  TEST FOR X NEAR NEGATIVE INTEGER OR ZERO
C
 60   IF ( X-ERR ) 62,62,80
 62   Y=FLOAT(INT(X))-X
      IF ( ABS(Y)-ERR ) 130,130,64
 64   IF ( 1.-Y-ERR ) 130,130,70
C
C  X NOT NEAR A NEGATIVE INTEGER OR ZERO
C
 70   IF ( X-1. ) 80,80,110
 80   GX=GX/X
      X=X+1.
      GO TO 70
 110  Y=X-1.
      GY=1.+Y*(-.5771017+Y*(.9858540+Y*(-.8764218+Y*(.8328212+Y*
     1(-.5684729+Y*(.2548205+Y*(-.05149930)))))))
      GAMMA=GX*GY
 120  RETURN
 130  WRITE (6,1)
      RETURN
 1    FORMAT (/53H GAMMA ARG WITHIN .000001 OF BEING A NEGATIVE INTEGER/
     1)
 2    FORMAT (/44H GAMMA ARG GT 57, OVERFLOW, ANS SET TO 1.E75/)
      END
```

```
      SUBROUTINE JKNIFE (U1,U2,U3,U4)
C
C   CALCULATION OF POOLED ESTIMATE OF PARAMETEP AND ASSOCIATED STANDARD
C   ERROR OF ESTIMATE BY THE JACKKNIFE PROCEDURE
C
C   MAP FOR SDATA MATRIX
C
C      SDATA (J,1) TO SDATA(J,8)    PARAMETER ESTIMATES FROM SUBTEST J
C      SDATA(J,9)                   NO. OF EXAMINEES FOR SUBTEST J
C      SDATA(J,10)                  NO. OF ITEMS FOR SUBTEST J
C      SDATA(J,11)                  NO. OF OBSERVATIONS FOR SUBTEST J
C      SDATA(101,I)                 POOLED ESTIMATE FOR PARAMETER I
C      SDATA(102,I)                 ESTIMATED SE FOR PARAMETER I
C
      COMMON /BLOCK1/ SDATA(102,11),NTEST
      DIMENSION A(8),B(8),PRCNT(6),CONF(6)
      DATA CONF/4H70.0,4H80.0,4H90.0,4H95.0,4H97.5,4H99.0/
      DATA PRCNT/.70,.80,.90,.95,.975,.99/
C
      IF ( NTEST .LE. 1 ) RETURN
C
      DO 200 I=1,8
C
C   CALCULATION OF WEIGHTED PARAMETER ESTIMATE USING ALL SUBTEST RESULTS
C
      PALL=0.
      TOBS=0.
      DO 100 J=1,NTEST
      SDATA(J,11)=SDATA(J,9)*SDATA(J,10)
      TOBS=TOBS+SDATA(J,11)
  100 PALL=PALL+SDATA(J,I)*SDATA(J,11)
C
C   CALCULATION OF PSEUDOVALUES PER SUBTEST FOR A GIVEN PARAMETER
C
      SP=0.
      SPP=0.
      DO 150 J=1,NTEST
      P=NTEST*PALL/TOBS-(NTEST-1.)*(PALL-SDATA(J,I)*SDATA(J,11))/
     1      (TOBS-SDATA(J,11))
      SP=SP+P
  150 SPP=SPP+P*P
C
C   CALCULATION OF POOLED ESTIMATE OF PARAMETER AND ESTIMATE OF STANDARD
C   ERROR OF ESTIMATE ASSOCIATED WITH PARAMETER
C
      SDATA(101,I)=SP/NTEST
      SDATA(102,I)=0.
      T=(SPP-SP*SP/NTEST)/(NTEST*(NTEST-1.))
      IF ( T .GT. 0. ) SDATA(102,I)=SQRT(T)
C
C
  200 CONTINUE
C
C
```

```
      WRITE (6,1) ((SDATA(J,I),I=1,8),J=101,102)
C
C
C  COMPUTE CONFIDENCE INTERVALS FOR PARAMETERS
C  (DF=NUMBER OF SUBTESTS MINUS ONE)
C
      DO 300 J=3,6
      CALL TTABLE (T,NTEST-1,PRCNT(J))
      WRITE (6,2) CONF(J)
      DO 250 I=1,8
      TEMP=T*SDATA(102,I)
      A(I)=SDATA(101,I)-TEMP
  250 B(I)=SDATA(101,I)+TEMP
      WRITE (6,3) (A(K),K=1,8),(B(K),K=1,8)
  300 CONTINUE
C
      U1=SDATA(101,1)
      U2=SDATA(101,2)
      U3=SDATA(101,3)
      U4=SDATA(101,4)
C
      RETURN
C
  1.  FORMAT (//5H MEAN8E15.5/5H SE  8E15.5//)
  2   FORMAT (1X,A4,1X,27HPERCENT CONFIDENCE INTERVAL)
  3.  FORMAT (5H FROM8E15.5/5H TO  8E15.5//)
      END
```

```
      SUBROUTINE PEARSN(U1,U2,U3,U4,L1,L2,STEP)
C
C   GRADUATION OF FREQUENCY DISTRIBUTIONS WITH PEARSON CURVES
C
C   PRIMARY REFERENCE
C
C   ELDERTON, W.P. AND JOHNSON, N.L. SYSTEMS OF FREQUENCY CURVES.
C   LONDON/CAMBRIDGE UNIVERSITY PRESS/1969.  (PAGES 35-109)
C
C   ARGUMENTS OF SUBROUTINE
C
C      U1    MEAN
C      U2    2ND CENTRAL MOMENT (VARIANCE)
C      U3    3RD CENTRAL MOMENT
C      U4    4TH CENTRAL MOMENT
C      L1    LOWER LIMIT OF INDEX
C      L2    UPPER LIMIT OF INDEX
C    STEP    DESIRED STEP SIZE IN GOING FROM L1 TO L2
C
C   REQUIRED SUBROUTINES
C
C    GAMMA  EXP  ABS  SQRT  COS  ATAN
C
      REAL M,M1,M2,L1,L2,LAMBDA
      DIMENSION CF(4),RR(4),RI(4)
C
C   COMPUTATION OF INDEX OF SKEWNESS (B1) AND DEGREE OF KURTOSIS (B2)
C   AND CRITERION VALUE USED IN THE SELECTION OF APPROPRIATE PEARSON
C   CURVE
C
      XO=0.
      XN=0.
      NHIGH=0
      CUMP=0.
      PI=3.1415927
      TPI=2.*PI
      B1=U3*U3/(U2**3)
      B2=U4/(U2*U2)
      Z1=B1
      Z2=B2
      CRIT1=(B1*(B2+3.)**2)/(4.*(4.*B2-3.*B1)*(2.*B2-3.*B1-6.))
      WRITE (6,14) U1,U2,U3,U4
      WRITE (6,1) B1,B2,CRIT1
      IF ( U2 .GT. 0. ) GO TO 60
      WRITE (6,15)
      RETURN
60    IF ( L1 .LT. L2 .AND. STEP .GT. 0. ) GO TO 65
      WRITE (6,16)
      RETURN
65    CONTINUE
      A=4.*B2-3.*B1
      B=3.*B1-2.*B2+6.
      CRIT2=(A*(10.*B2-12.*B1-18.)**2-B1*(B2+3.)**2*(8.*B2-9.*B1-12.))/
     1      (B*(B1*(B2+3.)**2+4.*A*B))
```

```
      CRIT3=5.*B2-6.*B1-9.
      CRIT4=2.*B2-3.*B1-6.
      WRITE (6,23) CRIT2,CRIT3,CRIT4
C
C  TEST FOR VALUES OF CRITERIA APPROXIMATING THEORETICAL VALUES
C
      IF ( CRIT1.LE. .02 .AND. CRIT1.GE. -.02 ) CRIT1=0.
      IF ( CRIT1.LE. 1.02 .AND. CRIT1.GE. .98 ) CRIT1=1.
      IF ( CRIT2 .GE. -.02 .AND. CRIT2 .LE. .02 ) CRIT2=0.
      IF ( CRIT3 .GE. -.02 .AND. CRIT3 .LE. .02 ) CRIT3=0.
      IF ( CRIT4 .GT. -.02 .AND. CRIT4 .LT. .02 ) CRIT4=0.
      IF ( B1 .GE. 3.98 .AND. B1 .LE. 4.02 ) Z1=4.
      IF ( B2 .LE. 3.02 .AND. B2 .GE. 2.98 ) Z2=3.
      IF ( B2 .GE. 8.98 .AND. B2 .LE. 9.02 ) Z2=9.
C
C  TEST FOR CURVE BEING MAIN TYPE OR TRANSITION TYPE
C
      IF ( CRIT4 .EQ. 0. ) GO TO 600
      IF ( Z1 .EQ. 4. .AND. Z2 .EQ. 9. ) GO TO 800
      IF ( CRIT2 ) 80,79,80
 79   IF ( CRIT1 .LT. 0. .AND. CRIT3 .LT. 0. ) GO TO 700
      IF ( CRIT1 .GT. 1. .AND. CRIT4 .GT. 0. ) GO TO 850
      IF ( CRIT1.LT.0..AND.CRIT3.GT.0..AND.CRIT4.LT.0. ) GO TO 750
 80   IF ( CRIT1) 100,400,90
 90   IF ( CRIT1-1.) 200,500,300
C
C  CURVE I *FIRST MAIN TYPE*
C
 100  WRITE (6,4)
      R=6.*(B2-B1-1.)/(6.+3.*B1-2.*B2)
      C=B1*(R+2.)**2+16.*(R+1.)
      A12=SQRT(U2*C)/2.
      C=R*(R+2.)*SQRT(B1/C)
      M1=(R-2.-C)/2.
      M2=(R-2.+C)/2.
C
C  IF U3 IS POSITIVE, M2 IS POSITIVE ROOT
C
      IF ( U3 .LE. 0. ) GO TO 120
      IF ( M2 .GE. M1 ) GO TO 120
      TEMP=M2
      M2=M1
      M1=TEMP
 120  A1=(M1+1.)*A12/(M1+M2+2.)
      A2=A12-A1
      YE=(1./A12)*(((M1+1.)**M1*(M2+1.)**M2)/(M1+M2+2.)**(M1+M2))*
     1(GAMMA(M1+M2+2.)/(GAMMA(M1+1.)*GAMMA(M2+1.)))
      WRITE (6,2)
      X=L1
      KK=1
 150  IF ( X .GT. L2 ) GO TO 1000
      T=X-U1
      R1=1.+T/A1
      R2=1.-T/A2
```

```
      IF ( R1 .LE. 0. .AND. R2 .GT. 0. ) P=YE*R2**M2
      IF ( R2 .LE. 0. .AND. R1 .GT. 0. ) P=YE*R1**M1
      IF ( R1 .LE. 0. .AND. R2 .LE. 0. ) P=YE
      IF ( R1 .GT. 0. .AND. R2 .GT. 0. ) P=YE*R1**M1*R2**M2
      IF ( R1 .LE. 0. .OR. R2 .LE. 0. ) NHIGH=1
      GO TO 5000
C
C  CURVE IV *SECOND MAIN TYPE*
C
 200  WRITE (6,5)
      R=6.*(B2-B1-1.)/(2.*B2-3.*B1-6.)
      M=(R+2.)/2.
      A=SQRT((U2/16.)*(16.*(R-1.)-B1*(R-2.)**2))
      V=SQRT((R*R*(R-2.)**2*B1)/(16.*(R-1.)-B1*(R-2.)**2))
C
C  V AND A HAVE OPPOSITE SIGN OF U3
C
      SGN=1.
      IF ( U3 .GT. 0. ) SGN=-1.
      A=SGN*ABS(A)
      V=SGN*ABS(V)
C
C  NOTE ... ARCTAN(-Z)=-ARCTAN(Z)
C
      THETA=ATAN(ABS(V/R))
      IF ( V/R .LT. 0. ) THETA=-THETA
      COST=COS(ABS(THETA))
C
C
      IF ( V-2. ) 225,225,250
C
C
 225  YO=1./(ABS(A)*FRV(R,V))
      GO TO 270
C
C  APPROXIMATION FOR YO
C
 250  TEMP=(COST    **2)/(3.*R)-1./(12.*R)-THETA*V
      YO=(1./A)*SQRT(R/TPI)*EXP(TEMP)/(COST     **(R+1.))
C
C
 270  CONTINUE
      WRITE (6,2)
      X=L1
      Y=V/R
      KK=2
 280  IF ( X .GT. L2 ) GO TO 1000
      T=X-U1
      Q=T/A-Y
      P=YO*(1.+Q*Q)**(-M)*EXP(-V*ATAN(Q))
      GO TO 5000
C
C  CURVE VI *THIRD MAIN TYPE*
C
```

```
300  WRITE (6,6)
     R=6.*(B2-B1-1.)/(6.+3.*B1-2.*B2)
     C=B1*(R+2.)**2+16.*(R+1.)
     A=SQRT(U2*C)/2.
C
C  A HAS SAME SIGN AS U3
C
     IF ( U3 .LT. 0. ) A=-A
     TEMP=R*(R+2.)/2.*SQRT(B1/C)
     Q1=-(R-2.)/2.+TEMP
     Q2=(R-2.)/2.+TEMP
C
C  R IS ALWAYS NEGATIVE HERE.  Q1 IS GREATER THAN Q2
C
     T1=Q2+1.
     T2=Q1-Q2-2.
     T3=Q1-1.
     A1=A*T3/T2
     A2=A*T1/T2
     YE=(T1**Q2*T2**(Q1-Q2)*GAMMA(Q1))/(ABS(A)
    1  *T3**Q1*GAMMA(T2+1.)*GAMMA(T1))
     WRITE (6,2)
     X=L1
     KK=3
350  IF ( X .GT. L2 ) GO TO 1000
     T=X-U1
     R1=ABS(1.+T/A1)
     R2=ABS(1.+T/A2)
     P=YE*R1**(-Q1)*R2**Q2
     GO TO 5000
C
C  TRANSITION CURVES
C
400  IF ( Z2 -3. ) 450,410,480
C
C  NORMAL CURVE OF ERROR *TRANSITION CURVE*
C
410  WRITE (6,7)
     YO=1./SQRT(TPI*U2)
     WRITE (6,2)
     X=L1
     KK=4
420  IF ( X .GT. L2 ) GO TO 1000
     P=YO*EXP(-((X-U1)**2)/(2.*U2))
     GO TO 5000
C
C  TYPE II CURVE *TRANSITION CURVE*
C
450  WRITE (6,8)
     M=(5.*B2-9.)/(6.-2.*B2)
     A2=(2.*U2*B2)/(3.-B2)
     YO=(1./SQRT(A2*PI))*GAMMA(M+1.5)/GAMMA(M+1.)
     WRITE (6,2)
     X=L1
```

```
      KK=5
  460 IF ( X .GT. L2 ) GO TO 1000
      T=X-U1
      R1=1.-T*T/A2
      IF ( R1 .LE. 0. ) P=YO
      IF ( R1 .GT. 0. ) P=YO*R1**M
      IF ( R1 .LE. 0. ) NHIGH=1
      GO TO 5000
C
C   TYPE VII CURVE *TRANSITION CURVE*
C
  480 WRITE (6,9)
      M=(5.*B2-9.)/(2.*B2-6.)
      A2=(2.*U2*B2)/(B2-3.)
      YO=(1./SQRT(A2*PI))*GAMMA(M)/GAMMA(M- .5)
      WRITE (6,2)
      X=L1
      KK=6
  490 IF ( X .GT. L2 ) GO TO 1000
      T=X-U1
      P=YO*(1.+T*T/A2)**(-M)
      GO TO 5000
C
C   TYPE V CURVE *TRANSITION CURVE*
C
  500 WRITE (6,10)
      P=4.+(8.+4.*SQRT(4.+B1))/B1
      G=(P-2.)*SQRT(U2*(P-3.))
      YO=G**(P-1.)/GAMMA(P-1.)
      ORIGIN=U1-G/(P-2.)
      IF ( U3 .LT. 0. ) ORIGIN=U1+G/(P-2.)
      WRITE (6,2)
      X=L1
      KK=7
  520 IF ( X .GT. L2 ) GO TO 1000
      X=X-ORIGIN
      T=ABS(X)
      P=YO*T**(-P)*EXP(-G/X)
      GO TO 5000
C
C   TYPE III CURVE *TRANSITION CURVE*
C
  600 IF ( B1 .EQ. 0. ) GO TO 80
      WRITE (6,11)
      LAMBDA=2.*U2/U3
      F=4./B1-1.
      A=(F+1.)/LAMBDA
      YE=LAMBDA*(((F+1.)**F)/(EXP(F+1.)*GAMMA(F+1.)))
      WRITE (6,2)
      X=L1
      KK=8
   20 IF ( X .GT. L2 ) GO TO 1000
      T=X-U1
      R1=1.+T/A
```

```
      IF ( R1 .LE. 0. ) P=YE*EXP(-LAMBDA*T)
      IF ( R1 .GT. 0. ) P=YE*R1**F*EXP(-LAMBDA*T)
      IF ( R1 .LE. 0. ) NHIGH=1
      GO TO 5000
C
C  TYPE VIII CURVE *TRANSITION CURVE*
C
 700  WRITE (6,19)
C
C  SOLUTION OF CUBIC EQUATION FOR VALUE OF M
C
C  WITH TYPE VIII, M IS RESTRICTED TO 0-1 RANGE
C
      CF(1)=16.*B1
      CF(2)=-24.*B1
      CF(3)=9.*B1-12.
      CF(4)=4.-B1
      CALL POLRT (CF,3,RR,RI,IER)
      DO 705 I=1,3
      M=RR(I)
      IF (M.GE.0..AND.M.LE.1..AND.RI(I).EQ.0. ) GO TO 710
 705  CONTINUE
      WRITE (6,25)
      GO TO 750
 710  T=(2.-M)*SQRT(U2*(3.-M)/(1.-M))
      A=T*(1.-M)/(2.-M)
C
C  A HAS OPPOSITE SIGN OF U3
C
      IF ( U3 .LT. 0. ) A=-A
      YE=((1.-M)*(2.-M)**M)/(T*(1.-M)**M)
      WRITE (6,2)
      X=L1
      KK=9
 720  IF ( X .GT. L2 ) GO TO 1000
      T=X-U1
      P=YE*(1.-T/A)**(-M)
      GO TO 5000
C
C  TYPE IX CURVE *TRANSITION CURVE*
C
 750  WRITE (6,20)
C
C  SOLUTION OF CUBIC EQUATION FOR VALUE OF M
C
C  WITH TYPE IX, M MUST BE NON-NEGATIVE
C
      CF(1)=16.*B1
      CF(2)=24.*B1
      CF(3)=9.*B1-12.
      CF(4)=B1-4.
      CALL POLRT (CF,3,RR,RI,IER)
      DO 755 I=1,3
      M=RR(I)
```

```
      IF ( M .GE. 0. .AND. RI(I) .EQ. 0. ) GO TO 769
  755 CONTINUE
      WRITE (6,26)
      GO TO 100
  769 T=(M+2.)*SQRT(U2*(M+3.)/(M+1.))
      A=(M+1.)*T/(M+2.)
      YE=(M+1.)**(M+1.)/(T*(M+2.)**M)
      WRITE (6,2)
      X=L1
      KK=10
  770 IF ( X .GT. L2 ) GO TO 1000
      T=X-U1
      P=YE*(1.+T/A)**M
      GO TO 5000
C
C  TYPE.X CURVE *TRANSITION CURVE*
C
  800 WRITE (6,21)
      A=SQRT(U2)
      YE=1./(2.718282*A)
      WRITE (6,2)
      X=L1
      KK=11
  820 IF ( X .GT. L2 ) GO TO 1000
      T=(X-U1)
      IF ( U3 .LT. 0. ) P=YE*EXP(T/A)
      IF ( U3 .GE. 0. ) P=YE*EXP(-T/A)
      GO TO 5000
C
C  TYPE XI CURVE *TRANSITION CURVE*
C
  850 WRITE (6,22)
C
C  SOLUTION OF CUBIC EQUATION FOR VALUE OF M
C
C  WITH TYPE XI, M MUST BE GREATER THAN 1
C
      CF(1)=16.*B1
      CF(2)=-24.*B1
      CF(3)=9.*B1-12.
      CF(4)=4.-B1
      CALL POLRT (CF,3,RR,RI,IER)
      DO 855 I=1,3
      M=RR(I)
      IF ( M .GT. 1. .AND. RI(I) .EQ. 0. ) GO TO 869
  855 CONTINUE
      WRITE (6,24)
      GO TO 300
  869 B=(M-2.)*SQRT(U2*(M-3.)/(M-1.))
      YE=((M-2.)**M)/(B*(M-1.)**(M-1.))
C
C  B HAS SAME SIGN AS U3
C
      B=ABS(B)
```

```
      IF ( U3 .LT. 0. ) B=-B
      A=B*(M-1.)/(M-2.)
      WRITE (6,2)
      X=L1
      KK=12
  870 IF ( X .GT. L2 ) GO TO 1000
      T=X-U1
      P=YE*(1.+T/A)**(-M)
      GO TO 5000
C
C  AREA UNDER CURVE APPROXIMATED BY TRAPEZOID FORMULA
C
 1000 AREA=STEP*(CUMP-(X0+XN)/2.)
      WRITE (6,13) AREA
      RETURN
C
C
 5000 WRITE (6,3) X,P
      IF ( P .GE. 1. ) P=0.
      CUMP=CUMP+P
      IF ( NHIGH .EQ. 0 ) GO TO 5010
      WRITE (6,18)
      NHIGH=0
 5010 IF ( X .EQ. L1 ) X0=P
      IF ( X .EQ. L2 ) XN=P
      X=X+STEP
      GO TO (150,280,350,420,460,490,520,620,720,770,820,870), KK
C
C
 1    FORMAT (    /18H INDEX OF SKEWNESS F21.5/19H DEGREE OF KURTOSIS
     1F20.5/16H CRITERION VALUEF23.5)
 2    FORMAT (5X,5HINDEX,5X,13HRELATIVE FREQ//)
 3    FORMAT (1X,F9.3,F18.5)
 4    FORMAT (/22H TYPE I CURVE SELECTED/)
 5    FORMAT (/23H TYPE IV CURVE SELECTED/)
 6    FORMAT (/23H TYPE VI CURVE SELECTED/)
 7    FORMAT (/28H NORMAL ERROR CURVE SELECTED/)
 8    FORMAT (/23H TYPE II CURVE SELECTED/)
 9    FORMAT (/24H TYPE VII CURVE SELECTED/)
 10   FORMAT (/22H TYPE V CURVE SELECTED/)
 11   FORMAT (/24H TYPE III CURVE SELECTED/)
 13   FORMAT (//15H APPROX AREA ISF15.7//)
 14   FORMAT (////49H APPROXIMATION OF DISTRIBUTION WITH PEARSON CURVE//
     121H ESTIMATED PARAMETERS///5H MEANF34.5/9H VARIANCEF30.5/19H 3RD C
     2ENTRAL MOMENT F20.5/19H 4TH CENTRAL MOMENTF20.5)
 15   FORMAT (//23H NO CURVE WHEN U(2) = 0//)
 16   FORMAT (//38H INVALID LIMITS AND/OR DELTA ARGUMENTS//)
 18   FORMAT (1H+,30X,32HORDINATE UNDEFINED AT THIS POINT)
 19   FORMAT (/25H TYPE VIII CURVE SELECTED/)
 20   FORMAT (/23H TYPE IX CURVE SELECTED/)
 21   FORMAT (/22H TYPE X CURVE SELECTED/)
 22   FORMAT (/23H TYPE XI CURVE SELECTED/)
 23   FORMAT (/7H LAMBDA,E36.5/10H 5B2-6B1-9,F29.5/10H 2B2-3B1-6,F29.5/)
 24   FORMAT (/22H M .LE. 1. FOR TYPE XI /)
```

```
25    FORMAT (/29H M OUT OF RANGE FOR TYPE VIII /)
26    FORMAT (/23H M NEGATIVE FOR TYPE IX /)
      END
```

```
      SUBROUTINE POLRT (XCOF,M,ROOTR,ROOTI,IER)
C  COMPUTATION OF THE REAL AND COMPLEX ROOTS OF A REAL POLYNOMIAL
C
C  METHOD:  NEWTON-RAPHSON ITERATIVE TECHNIQUE.  THE FINAL ITERATIONS ON
C        EACH ROOT ARE PERFORMED USING THE ORIGINAL POLYNOMIAL RATHER
C        THAN THE REDUCED POLYNOMIAL TO AVOID ACCUMULATED ERRORS IN THE
C        POLYNOMIAL.
C
C  LIMITATIONS:  LIMITED TO 36TH ORDER POLYNOMIAL OR LESS.
C                FLOATING POINT OVERFLOW MAY OCCUR FOR HIGH ORDER
C                POLYNOMIALS BUT WILL NOT AFFECT THE ACCURACY OF THE
C                RESULTS.
C
C  PARAMETERS
C
C  XCOF    VECTOR OF M+1 COEFFICIENTS OF THE POLYNOMIAL ORDERED FROM
C             SMALLEST TO LARGEST POWER
C  COF     WORKING VECTOR OF LENGTH M+1
C  M       ORDER OF POLYNOMIAL
C  ROOTR   RESULTANT VECTOR OF LENGTH M CONTAINING REAL ROOTS
C  ROOTI   RESULTANT VECTOR OF LENGTH M CONTAINING THE CORRESPONDING
C           IMAGINARY ROOTS
C  IER     ERROR CODE RETURNED WHERE
C             0 = NO ERROR
C             1 = M LESS THAN 1
C             2 = M GREATER THAN 36
C             3 = UNABLE TO DETERMINE ROOT WITH 500 ITERATIONS ON 5
C                 STARTING VALUES
C             4 = HIGH ORDER COEFFICIENT IS ZERO
C
C  SUBROUTINE TAKEN FROM IBM/SSP
      DIMENSION XCOF(1),COF(36),ROOTR(1),ROOTI(1)
      IFIT=0
      N=M
      IER=0
      IF ( XCOF(N+1) ) 10,25,10
 10   IF ( N ) 15,15,32
C
C  SET ERROR CODE TO 1
C
 15   IER=1
 20   RETURN
C
C  SET ERROR CODE TO 4
C
```

```
25    IER=4
      GO TO 20
C
C  SET ERROR CODE TO 2
C
30    IER=2
      GO TO 20
32    IF ( N-36 ) 35,35,30
35    NX=N
      NXX=N+1
      N2=1
      KJ1=N+1
      DO 40 L=1,KJ1
      MT=KJ1-L+1
40    COF(MT)=XCOF(L)
C
C  SET INITIAL VALUES
C
45    XO=.5001010E-2
      YO=.1000101E-1
C
C  ZERO INITIAL VALUE COUNTER
C
      IN=0
50    X=XO
C
C  INCREMENT INITIAL VALUES AND COUNTER
C
      XO=-10.*YO
      YO=-10.*X
C
C  SET X AND Y TO CURRENT VALUE
C
      X=XO
      Y=YO
      IN=IN+1
      GO TO 59
55    IFIT=1
      XPR=X
      YPR=Y
C
C  EVALUATE POLYNOMIAL AND DERIVATIVES
C
59    ICT=0
60    UX=0.
      UY=0.
      V=0.
      YT=0.
      XT=1.
      U=COF(N+1)
      IF ( U ) 65,130,65
65    DO 70 I=1,N
      L=N-I+1
```

```
      XT2=X*XT-Y*YT
      YT2=X*YT+Y*XT
      U=U+COF(L)*XT2
      V=V+COF(L)*YT2
      FI=I
      UX=UX+FI*XT*COF(L)
      UY=UY-FI*YT*COF(L)
      XT=XT2
 70   YT=YT2
      SUMSQ=UX*UX+UY*UY
      IF ( SUMSQ ) 75,110,75
 75   DX=(V*UY-U*UX)/SUMSQ
      X=X+DX
      DY=-(U*UY+V*UX)/SUMSQ
      Y=Y+DY
 78   IF ( ABS(DY)+ABS(DX)-1.0E-5 ) 100,80,80
C
C  STEP ITERATION COUNTER
C
 80   ICT=ICT+1
      IF ( ICT-500 ) 60,85,85
 85   IF ( IFIT ) 100,90,100
 90   IF ( IN-5 ) 50,95,95
C
C  SET ERROR CODE TO 3
C
 95   IER=3
      GO TO 20
 100  DO 105 L=1,NXX
      MT=KJ1-L+1
      TEMP=XCOF(MT)
      XCOF(MT)=COF(L)
 105  COF(L)=TEMP
      ITEMP=N
      N=NX
      NX=ITEMP
      IF ( IFIT ) 120,55,120
 110  IF ( IFIT ) 115,50,115
 115  X=XPR
      Y=YPR
 120  IFIT=0
      IF ( X ) 122,125,122
 122  IF ( ABS(Y)-ABS(X)*1.0E-4 ) 135,125,125
 125  ALPHA=X+X
      SUMSQ=X*X+Y*Y
      N=N-2
      GO TO 140
 130  X=0.
      NX=NX-1
      NXX=NXX-1
 135  Y=0.
      SUMSQ=0.
      ALPHA=X
      N=N-1
 140  L1=1
```

```
      L2=2
      COF(L2)=COF(L2)+ALPHA*COF(L1)
145   DO 150 L=2,N
150   COF(L+1)=COF(L+1)+ ALPHA*COF(L)-SUMSQ*COF(L-1)
155   ROOTI(N2)=Y
      ROOTR(N2)=X
      N2=N2+1
      IF ( SUMSQ ) 160,165,160
160   Y=-Y
      SUMSQ=0.
      GO TO 155
165   IF ( N ) 20,20,45
      END
```

```
      SUBROUTINE SUBTST(NDICH,KPOP,NDISK)
C
C  CALCULATION OF PARAMETER ESTIMATES FROM SUBTEST RESULTS
C
C  PARAMETERS ESTIMATED:  MEAN TEST SCORE                              Z(1)
C                         VARIANCE OF TEST SCORES                      Z(2)
C                         3RD CENTRAL MOMENT OF TEST SCORES            Z(3)
C                         4TH CENTRAL MOMENT OF TEST SCORES            Z(4)
C                         VARIANCE COMPONENT FOR ITEMS                 Z(5)
C                         (VARIANCE OF ITEM DIFFICULTY INDICES)
C                         VARIANCE COMPONENT FOR EXAMINEES             Z(6)
C                         VARIANCE COMPONENT FOR INTERACTION           Z(7)
C                         ESTIMATED RELIABILITY OF SINGLE ITEM         Z(8)
C
      COMMON /BLOCK1/ SDATA(102,11),NTEST
      DIMENSION FMT(162)
      DIMENSION X(300),SPLUS(150),SPLUS2(150),PIJ(11175),P(150),Z(8)
C
C
C
      NRDR=5
      IF ( NDISK .GT. 0 ) NRDR=2
C
C
      WRITE (6,3)
      DO 500 I=1,NTEST
C
      READ (5,7) NSPT,IPT
      CALL RDFMT (FMT,NC)
      NC=NC-1
C
C  IF THERE ARE MORE THAN 100 SUBTESTS, THE REMAINING SUBTEST RESULTS
C  ARE IGNORED.  ALSO, ANY SUBTEST HAVING MORE THAN 150 ITEMS IS
C  IGNORED.
C
      IF ( I .LE. 100 .AND. IPT .LE. 150 ) GO TO 75
      WRITE (6,5) I
      DO 50 J=1,NSPT
   50 READ (NRDR,FMT) (X(K),K=1,IPT)
      GO TO 500
   75 CONTINUE
C
C
      SDATA(I,9)=NSPT
      SDATA(I,10)=IPT
      WRITE (6,4) I,NSPT,IPT,(FMT(J),J=1,NC)
C
C
      SY=0.
      SY2=0.
      SY3=0.
      SY4=0.
      SP=0.
      SP2=0.
```

```
      SP3=0.
      SP4=0.
      IF ( NDICH .EQ. 1 ) GO TO 105
      NCOV=IPT*(IPT-1)/2
      DO 100 J=1,NCOV
 100  PIJ(J)=0.
 105  DO 110 J=1,IPT
      P(J)=0.
      SPLUS(J)=0.
 110  SPLUS2(J)=0.
      DO 200 L=1,NSPT
      READ (NRDR,FMT) (X(K),K=1,IPT)
      Y=0.
      DO 120 K=1,IPT
      T=X(K)
      P(K)=P(K)+T
 120  Y=Y+T
      NN=IPT-1
      DO 130 J=1,NN
      MM=J+1
      DO 130 K=MM,IPT
      LSUB=(J-1)*IPT+K-J*(J+1)/2
 130  PIJ(LSUB)=PIJ(LSUB)+X(J)*X(K)
      DO 140 K=1,IPT
      SPLUS(K)=SPLUS(K)+Y*X(K)/IPT
 140  SPLUS2(K)=SPLUS2(K)+Y*Y*X(K)/(IPT*IPT)
      SY=SY+Y
      SY2=SY2+Y**2
      SY3=SY3+Y**3
 200  SY4=SY4+Y**4
C
C  CALCULATION OF COMPONENTS OF VARIANCE FOR SUBTEST MATRIX
C
      CXX=SY*SY/(NSPT*IPT)
      SSE=SY2/IPT-CXX
      T=0.
      DO 300 J=1,IPT
 300  T=T+P(J)*P(J)
      SSI=T/NSPT-CXX
      SST=SY-CXX
      SSIE=SST-SSE-SSI
      ERR=SSIE/((IPT-1.)*(NSPT-1.))
      Z(5)=(SSI/(IPT-1.)-ERR)/NSPT
      Z(6)=(SSE/(NSPT-1.)-ERR)/IPT
      Z(7)=ERR
C
C  ESTIMATION OF RELIABILITY OF SINGLE ITEM
C
      FMSE=SSE/(NSPT-1.)
      T=(NSPT-1.)*(IPT-1.)
      FMP=(T-2.)/T
      Z(8)=(FMSE-FMP*ERR)/(IPT*FMP*ERR)
C
C
```

```
      DO 350 J=1,IPT
      P(J)=P(J)/NSPT
      T=P(J)
      SP=SP+T
      SP2=SP2+T**2
      SP3=SP3+T**3
  350 SP4=SP4+T**4
C
      WRITE (6,6) (P(K),K=1,IPT)
C
C  ESTIMATE OF POPULATION MEAN AND VARIANCE WHEN ITEM SCORED
C  NON-DICHOTOMOUSLY
C
      IF ( NDICH .EQ. 0 ) GO TO 360
C
      Z(1)=(KPOP/FLOAT(IPT))*(SY/NSPT)
      Z(2)=((SSE/(IPT*(NSPT-1.)))-((1.-FLOAT(IPT)/KPOP)*ERR/IPT))*
     1     KPOP*KPOP*(NSPT-1.)/NSPT
      Z(3)=0.
      Z(4)=0.
C
      GO TO 396
C
C
C  CALCULATION OF G STATISTICS USED IN ESTIMATING MOMENTS
C
  360 G1=(SY/NSPT)**4
      G2=(SY/NSPT)**2*(SY2/NSPT)
      G3=SP*SP*SP2
      G4=(SY2/NSPT)**2
      G5=SP2*SP2
      G6=(SY/NSPT)*(SY3/NSPT)
      G7=SP*SP3
      G8=SY4/NSPT
      G9=SP4
      G11=(SY2/NSPT)*SP2
      G12=(SY/NSPT)**3
      G18=(SY/NSPT)*(SY2/NSPT)
      G19=SP*SP2
      G20=SY3/NSPT
      G21=SP3
      G23=(SY/NSPT)**2
      G24=SY2/NSPT
      G25=SP2
      G26=SY/NSPT
      G10=0.
      G14=0.
      G15=0.
      G16=0.
      DO 375 J=1,IPT
      G10=G10+P(J)*SPLUS(J)/NSPT
      G15=G15+P(J)*SPLUS2(J)/NSPT
  375 G16=G16+P(J)*P(J)*SPLUS(J)/NSPT
      G22=G10*IPT
```

```
      G10=G10*SY/NSPT*IPT
      G15=G15*IPT*IPT
      G16=G16*IPT
      NN=IPT-1
      DO 390 J=1,NN
      MM=J+1
      DO 390 K=MM,IPT
      LSUB=(J-1)*IPT+K-J*(J+1)/2
  390 G14=G14+P(J)*P(K)*PIJ(LSUB)/NSPT
      G14=G14*2.+SP3
C
C  ESTIMATE OF POPULATION MEAN AND VARIANCE
C  (ITEMS SCORED DICHOTOMOUSLY)
C
C
      A=KPOP/FLOAT(IPT)
      B=A*(KPOP-1.)/(IPT-1.)
      C=B*(KPOP-2.)/(IPT-2.)
      D=C*(KPOP-3.)/(IPT-3.)
C
      Z(1)=A*G26
      Z(2)=A*(G26-G25)+B*(G24-G26-G23+G25)
      Z(2)=Z(2)*NSPT/(NSPT-1.)
C
C  ESTIMATE OF 3RD AND 4TH CENTRAL MOMENTS
C  (ITEMS SCORED DICHOTOMOUSLY)
C
      Z(3)=A*(G26-3.*G25+2.*G21)+
     1     B*(3.*G24-3.*G26-3.*G23+9.*G25-6.*G22+6.*G19-6.*G21)+
     2     C*(2.*G26-3.*G24-6.*G25+3.*G23+6.*G22+4.*G21-6.*G19)+
     3     C*(G20-3.*G18+2.*G12)
C
C
      Z(4)=A*(G26-4.*G25+6.*G21-3.*G9)+
     1     B*(-7.*G26+28.*G25+7.*G24-4.*G23-24.*G22-42.*G21+18.*G19+
     2     12.*G16+12.*G14+21.*G9-12.*G7-9.*G5)+
     3     C*(12.*G26-48.*G25-18.*G24+12.*G23+60.*G22+72.*G21+6.*G20-
     4     48.*G19-12.*G18-36.*G16-12.*G15-24.*G14+6.*G12+6.*G11+24.*G10
     5     -36.*G9+36.*G7+18.*G5-18.*G3)+
     6     D*(-6.*G26+11.*G24-6.*G20+G8+24.*G25-8.*G23-36.*G22+12.*G18+
     7     12.*G15-4.*G6-36.*G21+30.*G19+24.*G16+12.*G14-6.*G12-6.*G11-
     8     24.*G10+6.*G2+18.*G9-24.*G7-9.*G5+18.*G3-3.*G1)
C
C
  396 DO 400 J=1,8
  400 SDATA(I,J)=Z(J)
C
C
  500 CONTINUE
      IF ( NTEST .GT. 100 ) NTEST=100
C
C
      WRITE (6,1)
      DO 550 I=1,NTEST
```

```
550  WRITE (6,2) I,(SDATA(I,J),J=1,8)
C
C
     RETURN
C
C
1     FORMAT (///25X,21HESTIMATES OF MOMENTS ,33X,
    122HCOMPONENTS OF VARIANCE/8X,
    257H---------------------------------------------------------,3X
    3,57H---------------------------------------------------------/
    48H SUBTEST,5X,4HMEAN, 9X,8HVARIANCE,10X,2HU3,13X,2HU4,
    511X,6HVAR(I), 9X,6HVAR(E), 8X,7HVAR(IE), 9X,6HTHETA*//)
2     FORMAT (1X,I4,8E15.5)
3     FORMAT (//8H SUBTEST,2X,9HEXAMINEES,3X,5HITEMS,3X,6HFORMAT//)
4     FORMAT (/1X,I4,2I10,5X,25A4/(30X,25A4))
5     FORMAT (8H SUBTEST15,8H IGNORED)
6     FORMAT (/30X,23HITEM DIFFICULTY INDICES//(30X,10F8.3))
7     FORMAT (2I4)
      END
```

ATTACHMENT 1

SAMPLE INPUT

```
STR2
01 1 1   1011111110
02 1 1   1111101011
03 1 1   1110100000
04 1 1   1110000000
05 1 1   0000000000
06 1 1   1101010001
07 2 1   1110101010
08 2 1   1100100000
09 2 1   0000011010
10 2 1   0100000000
11 2 1   1111101010
12 2 1   1001001000
13 3 1   0100100000
14 3 1   0111100010
15 3 1   0000000000
16 3 1   0000000000
17 3 1   1101001110
18 2 1   0000000000
01 1 2   1111110011
02 1 2   1011100000
03 1 2   1100101000
04 1 2   1111110000
05 1 2   1011110010
06 1 2   1110110000
07 2 2   1010100000
08 2 2   1111110010
09 2 2   1101111010
10 2 2   1111110000
11 3 2   0001110000
12 3 2   1111111100
13 3 2   1101000000
14 3 2   0011110000
01 1 3   1101111101
02 1 3   0101001000
03 1 3   1001011101
04 1 3   0010010000
05 1 3   1111111111
06 1 3   1101110100
07 2 3   0100000100
08 2 3   0111111110
09 2 3   1000000000
10 [illegible] 3   1001000000
11 [illegible] 3   1111111100
12 3 3   1111000100
13 [illegible] 3   0000000000
01 1 4   1101001100
02 1 4   0010001000
03 1 4   1111011011
04 1 4   1111111111
05 1 4   1111011111
06 2 4   0111010000
07 2 4   1111011111
08 [illegible] [illegible]   0000000000
09 [illegible] 4   0110001100
```

```
10 3 4      0011001000
11 3 4      1111001110
12 3 4      0011001000
13 3 4      0000000000
01 1 5      1001001010
02 1 5      0000000000
03 1 5      1000000000
04 1 5      0000000000
05 2 5      0101111010
06 2 5      1110010100
07 2 5      0000000000
08 2 5      0000000000
09 3 5      1011111100
10 3 5      0000000000
11 3 5      0000000000
12 3 5      0000000000
END
FIRST YEAR WORD SPELLING PROJECT      SHOEMAKER/OKADA
00500050001 1
00180010
(10X,10F1,0)
END OF FORMAT
00140010
(10X,10F1.0)
END OF FORMAT
00130010
(10X,10F1,0)
END OF FORMAT
00130010
(10X,10F1,0)
END OF FORMAT
00120010
(10X,10F1,0)
END OF FORMAT
/*
//
```

ATTACHMENT 2

SAMPLE OUTPUT

CARD IMAGES LOADED ON SCRATCH FILE 2

01	1	1	1011111110
02	1	1	1111101011
03	1	1	1110100000
04	1	1	1110000000
05	1	1	0000000000
06	1	1	1101010001
07	2	1	1110101010
08	2	1	1100100000
09	2	1	0000011010
10	2	1	0100000000
11	2	1	1111101010
12	2	1	1001001000
13	3	1	0100100000
14	3	1	0111100010
15	3	1	0000000000
16	3	1	0000000000
17	3	1	1101001110
18	2	1	0000000000
01	1	2	1111110011
02	1	2	1011100000
03	1	2	1100101000
04	1	2	1111110000
05	1	2	1011110010
06	1	2	1110110000
07	2	2	1010100000
08	2	2	1111110010
09	2	2	1101111010
10	2	2	1111110000
11	3	2	0001110000
12	3	2	1111111100
13	3	2	1101000000
14	3	2	0011110000
01	1	3	1101111101
02	1	3	0101001000
03	1	3	1001011101
04	1	3	0010010000
05	1	3	1111111111
06	1	3	1101110100
07	2	3	0100000100
08	2	3	0111111110
09	2	3	1000000000
10	2	3	1001000000
11	3	3	1111111100
12	3	3	1111000100
13	3	3	0000000000
01	1	4	1101001100
02	1	4	0010001000
03	1	4	1111011011
04	1	4	1111111111
05	1	4	1111011111
06	2	4	0111010000
07	2	4	1111011111
08	2	4	0000000000
	2	4	0110001100

```
10 3 4    0C11C01000
11 3 4    1111CC111C
12 3 4    CC11CC1CCC
13 3 4    CCCCCCC0CC
01 1 5    1001C01010
02 1 5    CCCCCCC000
03 1 5    1CCCCCCCCC
04 1 5    CCCCCCC0CC
05 2 5    0101111010
06 2 5    111CC1C10C
07 2 5    CCCCCCC00C
08 2 5    CCCCCCC0CC
09 3 5    101111110C
10 3 5    CC0CC0000C
11 3 5    CCCCCCCC0C
12 3 5    CCCCCCC00C
END
```

FIRST YEAR WORD SPELLING PROJECT SHOEMAKER/CKADA

SPECIFICATIONS FOR PROBLEM SET

MAXIMUM TEST SCORE	50
NUMBER OF SUBTESTS	5
ITEM SCORING	0
NORMATIVE DISTRIBUTION	1

SUBTEST	EXAMINEES	ITEMS	FORMAT
1	18	10	(10X,10F1.0)

ITEM DIFFICULTY INDICES

0.556	0.611	0.389	0.389	0.444
0.167	0.389	0.111	0.389	0.111

SUBTEST	EXAMINEES	ITEMS	FORMAT
2	14	10	(10X,10F1.0)

ITEM DIFFICULTY INDICES

0.857	0.643	0.714	0.786	0.929
0.714	0.214	0.071	0.286	0.071

SUBTEST	EXAMINEES	ITEMS	FORMAT
3	13	10	(10X,10F1.0)

ITEM DIFFICULTY INDICES

0.615	0.615	0.385	0.692	0.385
0.538	0.462	0.615	0.154	0.231

SUBTEST	EXAMINEES	ITEMS	FORMAT
4	13	10	(10X,10F1.0)

ITEM DIFFICULTY INDICES

0.462	0.615	0.769	0.692	0.077
0.385	0.769	0.462	0.385	0.308

SUBTEST	EXAMINEES	ITEMS	FORMAT
5	12	10	(10X,10F1.0)

ITEM DIFFICULTY INDICES

0.333	0.167	0.167	0.250	0.167
0.250	0.250	0.167	0.167	0.0

ESTIMATES OF MOMENTS

SUBTEST	MEAN	VARIANCE	U3	U4
1	0.17778E 02	0.15818E 03	-0.21425E 02	0.36235E 05
2	0.26429E 02	0.53846E 02	0.17502E 03	-0.50351E 03
3	0.23462E 02	0.23005E 03	0.47123E 03	0.65943E 05
4	0.24615E 02	0.26558E 03	0.28235E 03	0.10394E 06
5	0.95833E 01	0.16934E 03	0.11818E 04	0.28543E 05
MEAN	0.20417E 02	0.17176E 03	0.35944E 03	0.45318E 05
SE	0.27593E 01	0.34959E 02	0.19986E 03	0.16838E 05

COMPONENTS OF VARIANCE

VAR(I)	VAR(E)	VAR(IE)	THETA'
0.21786E-01	0.60203E-01	0.15352E 00	0.39867E 00
0.10000E 00	0.18681E-01	0.14286E 00	0.13478E 00
0.20655E-01	0.89031E-01	0.14943E 00	0.60893E 00
0.39744E-01	0.10385E 00	0.11923E 00	0.88929E 00
-0.16834E-03	0.65825E-01	0.95539E-01	0.70526E 00
0.36755E-01	0.66007E-01	0.13493E 00	0.52356E 00
0.16713E-01	0.14039E-01	0.10458E-01	0.12696E 00

90.0 PERCENT CONFIDENCE INTERVAL

FROM	0.14533E 02	0.97222E 02	-0.66701E 02	0.94145E 04
TO	0.26300E 02	0.24631E 03	0.78559E 03	0.81222E 05
	0.11185E-02	0.36071E-01	0.11263E 00	0.25286E 00
	0.72392E-01	0.95943E-01	0.15723E 00	0.79426E 00

95.0 PERCENT CONFIDENCE INTERVAL

FROM	0.12755E 02	0.74698E 02	-0.19547E 03	-0.14343E 04
TO	0.28078E 02	0.26883E 03	0.91436E 03	0.92071E 05
	-0.96496E-02	0.27026E-01	0.10589E 00	0.17106E 00
	0.83160E-01	0.10499E 00	0.16397E 00	0.876[illegible]E 00

97.5 PERCENT CONFIDENCE INTERVAL

FROM	0.10776E 02	0.49621E 02	-0.33883E 03	-0.13513E 05
TO	0.30057E 02	0.29391E 03	0.10577E 04	0.10415E 06
	-0.21638E-01	0.16955E-01	0.98391E-01	0.79995E-01
	0.95148E-01	0.11506E 00	0.17147E 00	0.96713E 00

99.0 PERCENT CONFIDENCE INTERVAL

FROM	0.77363E 01	0.11109E 02	-0.55900E 03	-0.32062E 05
TO	0.33097E 02	0.23242E 03	0.12779E 04	0.12270E 06
	-0.40050E-01	0.14884E-02	0.86870E-01	-0.59863E-01
	0.11356E 00	0.13053E 00	0.18299E 00	0.11070E 01

ESTIMATED RELIABILITY OF TOTAL TEST SCORE IS 0.96321

APPROXIMATION OF NORMATIVE DISTRIBUTION WITH NEGATIVE HYPERGEOMETRIC DISTRIBUTION

ESTIMATED PARAMETERS

MEAN	20.41664
VARIANCE	171.76410
A21	0.94864

INDEX	RELATIVE FREQ	CUM REL FREQ
0	0.02221	0.02221
1	0.02426	0.04647
2	0.02522	0.07169
3	0.02578	0.09747
4	0.02613	0.12360
5	0.02633	0.14994
6	0.02644	0.17638
7	0.02648	0.20286
8	0.02646	0.22931
9	0.02639	0.25570
10	0.02628	0.28198
11	0.02614	0.30812
12	0.02597	0.33409
13	0.02577	0.35986
14	0.02555	0.38541
15	0.02530	0.41071
16	0.02504	0.43576
17	0.02476	0.46051
18	0.02446	0.48497
19	0.02414	0.50911
20	0.02380	0.53292
21	0.02345	0.55637
22	0.02309	0.57946
23	0.02270	0.60216
24	0.02231	0.62447
25	0.02189	0.64636
26	0.02147	0.66783
27	0.02102	0.68885
28	0.02056	0.70942
29	0.02009	0.72951
30	0.01960	0.74911
31	0.01909	0.76820

32	0.01857	0.78676
33	0.01802	0.80479
34	0.01746	0.82225
35	0.01688	0.83913
36	0.01627	0.85540
37	0.01565	0.87105
38	0.01500	0.88605
39	0.01432	0.90037
40	0.01361	0.91398
41	0.01287	0.92686
42	0.01210	0.93896
43	0.01128	0.95024
44	0.01041	0.96065
45	0.00949	0.97013
46	0.00849	0.97862
47	0.00739	0.98601
48	0.00617	0.99218
49	0.00476	0.99694
50	0.00298	0.99992

ALL INPUT PROCESSED

ATTACHMENT 3

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