รายการอ้างอิง

ภาษาไทย

ธิดาเดียว มยุรีสวรรค์. การเปรียบเทียบวิธีการประมาณช่วงความเชื่อมั่นสำหรับค่าสัดส่วนประชากร. วิทยานิพนธ์ปริญญามหาบัณฑิต ภาควิชาสถิติ บัณฑิตวิทยาลัย จุฬาลงกรณ์มหาวิทยาลัย, 2534.

ประชุม สุวัตถี. ทฤษฎีการอนุมานเชิงสถิติ. กรุงเทพมหานคร: สำนักพิมพ์โอเดียนสโตร์, 2527.

สุชาดา กีระนันทน์. การอนุมานเชิงสถิติ:ทฤษฎีขั้นต้น. กรุงเทพมหานคร: สำนักพิมพ์จุฬาลงกรณ์มหาวิทยาลัย, 2530.

ภาษาอังกฤษ

หนังสือ

Box, G.E.P. and Tiao, G.C. Bayesian Inference in Statistical Analysis. Mass: Addison-Wesley, 1973.

Casella, G. and Berger, R.L. Statistical Inference. California: Wadsworth and Brooks/Cole, 1990.

Hogg, R.V. and Craig, A.T. Introduction to Mathematical Statistics. 4th ed. New york: Macmillan, 1978.

Hogg, R.V. and Tanis, E.A. Probability and Statistical Inference. 3rd ed. New York: Macmillan, 1983.

Lindley, D.V. Introduction to Probability and Statistics from a Bayesian Viewpoint Part2 Inference. Cambridge: Cambridge University Press, 1970.

Mood, A.M., Graybill, F.A. and Boes, D.C. Introduction to the Theory of Statistics. 3rd ed. New York: McGraw-Hill Book, 1974.

Paul Bratley and Bennett L.Fox and Linus E. Schrage. A Guide to Simulation. 2nd ed. New York: Springer-Verlag, 1987.

บทความ

Arthur Cohen. Improved Confidence Intervals for the Variance of a Normal Distribution. J.Am.Statist.Assoc. 67 (1972): 382-387.

Best, D.J. and Roberts, D.E. Algorithm AS91 The Percentage Points of the χ^2 Distribution. Appl. Statist. 24 (1975): 385-388.

Guenther, William C. Shortest Confidence Interval. Amer.Statist. 23 (1969): 22-25.

Hill, I.D. and Pike, M.C. Algorithm 299 Chi-Square Integral. Commun. Ass. Comput. Mach. 10 (1967): 243-244.

Lindley, D.V., East, D.A. and Hamilton, P.A. Tables for making inferences about the variance of a normal distribution. Biometrika. 47 (1960): 433-437.

Roger Crisman. Shortest Confidence Interval for the Standard Deviation of a Normal Distribution. J. Undergrad. Math. 7 (1975): 57-62.

Tate, R.F. and Klett, G.W. Optimum Confidence Interval for the Variance of a Normal Distribution. J.Am.Statist.Assoc. 54 (1959): 674-682.

ภาคผนวก

ภาคผนวก ก.

โปรแกรมที่ใช้ในการวิจัย

```
C*********************************************************************
C      THIS PROGRAM TO COMPUTE CONFIDENCE LEVEL AND AVERAGE LENGTH OF
C      CONFIDENCE INTERVAL FROM 3 CONFIDENCE INTERVAL ESTIMATION
C      METHODS.
C*********************************************************************
       DIMENSION X(50),XX(50),D190(2000),P190(2000),D195(2000)
     * ,P195(2000),D199(2000),P199(2000),D1995(2000),P1995(2000)
     * ,D290(2000),P290(2000),D295(2000),P295(2000),D299(2000)
     * ,P299(2000),D2995(2000),P2995(2000),D390(2000),P390(2000)
     * ,D395(2000),P395(2000),D399(2000),P399(2000),D3995(2000)
     * ,P3995(2000)
       DOUBLE PRECISION AP1,AP2,AP3,AP4,L190,L195,L199,L1995
     * ,L290,L295,L299,L2995,L390,L395,L399,L3995,U190,U195,U199
     * ,U1995,U190,U295,U299,U2995,U390,U395,U399,U3995,CL190,CL195
     * ,CL199,CL1995,CL290,CL295,CL299,CL2995,CL390,CL395,CL399
     * ,CL3995,AL190,AL195,AL199,AL1995,AL290,AL295,AL299,AL2995
     * ,AL390,AL395,AL399,AL3995,CC1,CC2,CC3,CC4
       INTEGER R
       REAL MEAN,MEANX,MSB,MSW
       COMMON/SEED/IX,KK
       IX = 65479
       KK = 0
```

```
      DATA AP1,AP2,AP3,AP4/0.1,0.05,0.01,0.005/
      DATA CC1,CC2,CC3,CC4/0.90,0.95,0.99,0.995/
      READ(5,10) MEAN,VAR,N
   10 FORMAT(F4.2,2X,F5.2,2X,I2)
      SDX = SQRT(VAR)
      MM = 2000
      R = N-1
      DATA S190,S195,S199,S1995/0.0,0.0,0.0,0.0/
      DATA S290,S295,S299,S2995/0.0,0.0,0.0,0.0/
      DATA S390,S395,S399,S3995,0.0,0.0,0.0,0.0/
      DATA SD190,SD195,SD199,SD1995/0.0,0.0,0.0,0.0/
      DATA SD290,SD295,SD299,SD2995/0.0,0.0,0.0,0.0/
      DATA SD390,SD395,SD399,SD3995/0.0,0.0,0.0,0.0/
      DATA Q190,Q195,Q199,Q1995/0.0,0.0,0.0,0.0/
      DATA Q290,Q295,Q299,Q2995/0.0,0.0,0.0,0.0/
      DATA Q390,Q395,Q399,Q3995/0.0,0.0,0.0,0.0/
C*********************************************************************
C                DIVISORS FOR CHI-SQUARE CONFIDENCE INTERVAL
C*********************************************************************
      A190 = VCHI2((AP1/2.),FLOAT(R))
      B190 = VCHI2((1.0-(AP1/2.)),FLOAT(R))
      A195 = VCHI2((AP2/2.),FLOAT(R))
      B195 = VCHI2((1.0-(AP2/2.)),FLOAT(R))
      A199 = VCHI2((AP3/2.),FLOAT(R))
      B199 = VCHI2((1.0-(AP3/2.)),FLOAT(R))
      A1995 = VCHI2((AP4/2.),FLOAT(R))
      B1995 = VCHI2((1.0-(AP4/2.)),FLOAT(R))
```

```
C***********************************************************************
C        DIVISORS FOR THE CONFIDENCE INTERVAL OF MINIMUM LENGTH
C***********************************************************************
      K = 2
      CALL DIV(R,K,CC1,A290,B290)
      CALL DIV(R,K,CC2,A295,B295)
      CALL DIV(R,K,CC3,A299,B299)
      CALL DIV(R,K,CC4,A2995,B2995)
C***********************************************************************
C        DIVISORS FOR THE BAYESIAN CONFIDENCE INTERVAL
C***********************************************************************
      K = 0
      CALL DIV(R,K,CC1,A390,B390)
      CALL DIV(R,K,CC2,A395,B395)
      CALL DIV(R,K,CC3,A399,B399)
      CALL DIV(R,K,CC4,A3995,B3995)
C***********************************************************************
      DO 540 K1 = 1,MM
      SX = 0
      SSX = 0
      DO 100 I = 1,N
      CALL NORMAL(MEAN,SDX,X(I))
      XX(I) = X(I)**2
C     PRINT,'X(I)  ',X(I)
      SX = SX+X(I)
      SSX = SSX+XX(I)
```

```
 100 CONTINUE
C**********************************************************************
C                    COMPUTE CONFIDENCE INTERVAL
C**********************************************************************
      U190 = (SSX-(N*SM)/A190
      L190 = (SSX-(N*SM)/B190
      D190(MM) = U190-L190
      P190(MM) = D190(MM)**2
      Q190 = Q190+P190(MM)
      U195 = (SSX-(N*SM)/A195
      L195 = (SSX-(N*SM)/B195
      D195(MM) = U195-L195
      P195(MM) = D195(MM)**2
      Q195 = Q195+P195(MM)
      U199 = (SSX-(N*SM)/A199
      L199 = (SSX-(N*SM)/B199
      D199(MM) = U199-L199
      P199(MM) = D199(MM)**2
      Q199 = Q199+P199(MM)
      U1995 = (SSX-(N*SM)/A1995
      L1995 = (SSX-(N*SM)/B1995
      D1995(MM) = U1995-L1995
      P1995(MM) = D1995**2
      Q1995 = Q1995+P1995(MM)
      IF (L190 .LT. VAR .AND. U190 .GT. VAR) S190 = S190+1.0
      IF (L195 .LT. VAR .AND. U195 .GT. VAR) S195 = S195+1.0
```

```
      IF (L199 .LT. VAR .AND. U199 .GT. VAR) S199 = S199+1.0
      IF (L1995 .LT. VAR .AND. U1995 .GT. VAR) S1995 = S1995+1.0
C***********************************************************************
      U290 = (SSX-(N*SM)/A290
      L290 = (SSX-(N*SM)/B290
      D290(MM) = U290-L290
      P290(MM) = D290(MM)**2
      Q290 = Q290+P290(MM)
      U295 = (SSX-(N*SM)/A295
      L295 = (SSX-(N*SM)/B295
      D295(MM) = U295-L295
      P295(MM) = D295(MM)**2
      Q295 = Q295+P295(MM)
      U299 = (SSX-(N*SM)/A299
      L299 = (SSX-(N*SM)/B299
      D299(MM) = U299-L299
      P299(MM) = D299(MM)**2
      Q299 = Q299+P299(MM)
      U2995 = (SSX-(N*SM)/A2995
      L2995 = (SSX-(N*SM)/B2995
      D2995(MM) = U2995-L2995
      P2995(MM) = D2995(MM)**2
      Q2995 = Q2995+P2995(MM)
      IF (L290 .LT. VAR .AND. U290 .GT. VAR) S290 = S290+1.0
      IF (L295 .LT. VAR .AND. U295 .GT. VAR) S295 = S295+1.0
      IF (L299 .LT. VAR .AND. U299 .GT. VAR) S299 = S299+1.0
```

```
      IF (L2995 .LT. VAR .AND. U2995 .GT. VAR) S2995 = S2995+1.0
C***********************************************************************
      U390 = (SSX-(N*SM)/A390
      L390 = (SSX-(N*SM)/B390
      D390(MM) = U390-L390
      P390(MM) = D390(MM)**2
      Q390 = Q390+P390(MM)
      U395 = (SSX-(N*SM)/A395
      L395 = (SSX-(N*SM)/B395
      D395(MM) = U395-L395
      P395(MM) = D395(MM)**2
      Q395 = Q395+P395(MM)
      U399 = (SSX-(N*SM)/A399
      L399 = (SSX-(N*SM)/B399
      D399(MM) = U399-L399
      P399(MM) = D399(MM)**2
      Q399 = Q399+P399(MM)
      U3995 = (SSX-(N*SM)/A3995
      L3995 = (SSX-(N*SM)/B3995
      D3995(MM) = U3995-L3995
      P3995(MM) = D3995(MM)**2
      Q3995 = Q3995+P3995(MM)
      IF (L390 .LT. VAR .AND. U390 .GT. VAR) S390 = S390+1.0
      IF (L395 .LT. VAR .AND. U395 .GT. VAR) S395 = S395+1.0
      IF (L399 .LT. VAR .AND. U399 .GT. VAR) S399 = S399+1.0
      IF (L3995 .LT. VAR .AND. U3995 .GT. VAR) S3995 = S3995+1.0
```

```
C*********************************************************************
      SD190 = SD190 + (U190-L190)
      SD195 = SD195 + (U195-L195)
      SD199 = SD199 + (U199-L199)
      SD1995 = SD1995 + (U1995-L1995)
      SD290 = SD290 + (U290-L290)
      SD295 = SD295 + (U295-L295)
      SD299 = SD299 + (U299-L299)
      SD2995 = SD2995 + (U2995-L2995)
      SD390 = SD390 + (U390-L390)
      SD395 = SD395 + (U395-L395)
      SD399 = SD399 + (U399-L399)
      SD3995 = SD3995 + (U3995-L3995)
  540 CONTINUE
C*********************************************************************
C         COMPUTE CONFIDENCE LEVEL AND AVERAGE LENGTH
C*********************************************************************
      CL190 = S190/FLOAT(MM)
      CL195 = S195/FLOAT(MM)
      CL199 = S199/FLOAT(MM)
      CL1995 = S1995/FLOAT(MM)
      CL290 = S290/FLOAT(MM)
      CL295 = S295/FLOAT(MM)
      CL299 = S299/FLOAT(MM)
      CL2995 = S2995/FLOAT(MM)
      CL390 = S390/FLOAT(MM)
```

```
      CL395 = S395/FLOAT(MM)
      CL399 = S399/FLOAT(MM)
      CL3995 = S3995/FLOAT(MM)
      AL190 = SD190/FLOAT(MM)
      AL195 = SD195/FLOAT(MM)
      AL199 = SD199/FLOAT(MM)
      AL1995 = SD1995/FLOAT(MM)
      AL290 = SD290/FLOAT(MM)
      AL295 = SD295/FLOAT(MM)
      AL299 = SD299/FLOAT(MM)
      AL2995 = SD2995/FLOAT(MM)
      AL390 = SD390/FLOAT(MM)
      AL395 = SD395/FLOAT(MM)
      AL399 = SD399/FLOAT(MM)
      AL3995 = SD3995/FLOAT(MM)
C***********************************************************************
C                         COMPUTE ANOVA F-TEST
C***********************************************************************
      CT90 = ((SD190+SD290+SD390)**2)/(3*MM)
      SST90 = (Q190+Q290+Q390)-CT90
      SSB90 = (((SD190**2)+(SD290**2)+(SD390**2))/MM)-CT90
      SSW90 = SST90-SSB90
      MSB90 = SSB90/(3-1)
      MSW90 = SSW90/(3*(MM-1))
      F90 = MSB90/MSW90
      CT95 = ((SD195+SD295+SD395)**2)/(3*MM)
```

```
      SST95 = (Q195+Q295+Q395)-CT95
      SSB95 = (((SD195**2)+(SD295**2)+(SD395**2))/MM)-CT95
      SSW95 = SST95-SSB95
      MSB95 = SSB95/(3-1)
      MSW95 = SSW95/(3*(MM-1))
      F95 = MSB95/MSW95
      CT99 = ((SD199+SD299+SD399)**2)/(3*MM)
      SST99 = (Q199+Q299+Q399)-CT99
      SSB99 = (((SD199**2)+(SD299**2)+(SD399**2))/MM)-CT99
      SSW99 = SST99-SSB99
      MSB99 = SSB99/(3-1)
      MSW99 = SSW99/(3*(MM-1))
      F99 = MSB99/MSW99
      CT995 = ((SD1995+SD2995+SD3995)**2)/(3*MM)
      SST995 = (Q1995+Q2995+Q3995)-CT995
      SSB995 = (((SD1995**2)+(SD2995**2)+(SD3995**2))/MM)-CT995
      SSW995 = SST995-SSB995
      MSB995 = SSB995/(3-1)
      MSW995 = SSW995/(3*(MM-1))
      F995 = MSB995/MSW995
C***********************************************************************
      WRITE(6,541) N,MEAN,VAR,CV
      WRITE(6,542) A190,A195,A199,A1995
      WRITE(6,542) B190,B195,B199,B1995
      WRITE(6,542) A290,A295,A299,A2995
      WRITE(6,542) B290,B295,B299,B2995
```

```
      WRITE(6,542) A390,A395,A399,A3995
      WRITE(6,542) B390,B395,B399,B3995
      WRITE(6,543) CL190,CL290,CL390,CL195,CL295,CL395,CL199,CL299,
     *             CL399,CL1995,CL2995,CL3995
      WRITE(6,543) AL190,AL290,AL390,AL195,AL295,AL395,AL199,AL299,
     *             AL399,AL1995,AL2995,AL3995
      WRITE(6,544) F90,F95,F99,F995
      WRITE(6,544) MSW90,MSW95,MSW99,MSW995
  541 FORMAT(1X,I2,F10.4,2X,F10.4,2X,F10.4)
  542 FORMAT(2X,F10.4,2X,F10.4,2X,F10.4,2X,F10.4)
  543 FORMAT(2X,F10.4,F10.4,1X,F10.4,1X,F10.4,1X,F10.4,1X,F10.4,
     *       1X,F10.4,1X,F10.4,1X,F10.4,1X,F10.4,1X,F10.4,1X,F10.4)
  544 FORMAT(2X,F10.4,2X,F10.4,2X,F10.4,2X,F10.4)
      STOP
      END
C***********************************************************************
C                          SUBROUTINE NORMAL
C***********************************************************************
      SUBROUTINE NORMAL(AMEAN,SD,EX)
      COMMON/SEED/IX,KK
      PI = 3.1415926
      IF(KK .EQ. 1) GOTO 10
      RONE = RAND(IX)
      RTWO = RAND(IX)
      ZONE = SQRT(-2*ALOG(RONE))*COS(2*PI*RTWO)
      ZTWO = SQRT(-2*ALOG(RONE))*SIN(2*PI*RTWO)
```

```
      EX = ZONE*SD+AMEAN
      KK = 1
      GOTO 15
   10 EX = ZTWO*SD+AMEAN
      KK = 0
   15 RETURN
      END
C**********************************************************************
C                           FUNCTION RANDOM
C**********************************************************************
      FUNCTION RAND(IX)
      IX = IX*16807
      IF (IX.LT.0) IX = IX+2147483647+1
      RAND = IX
      RAND = RAND*0.465661E-9
      RETURN
      END
C**********************************************************************
C                         SUBROUTINE DIV
C
C     EVALUATE DIVISORS FOR THE CONFIDENCE INTERVAL
C**********************************************************************
      SUBROUTINE DIV(R,K,CC,A,B)
      DIMENSION Y(1000)
      INTEGER R
      DOUBLE PRECISION Y1,Y2,Y,A,B,BN,ALPHA,CC,P,PC,AA,BB,GAM
```

```
      ALPHA = 1-CC
      BB = VCHI2((1-ALPHA/2.),FLOAT(R))
      IF (2*(R/2) .EQ. R) THEN
      M = (R/2)-1
      CALL FAC(M,GAM)
      ENDIF
      I = 2
      Y(1) = 0
      Y(2) = 0
    2 P = CHISQ(R,BB)
      PC = P-CC
      AA = VCHI2(PC,FLOAT(R))
      I = I+1
      Y1 = (AA**((R+K)/2.))*DEXP(-AA/2.)
      Y2 = (BB**((R+K)/2.))*DEXP(-BB/2.)
      Y(I) = (Y1 - Y2)/((2**(R/2))*GAM)
      IF ((Y(I) .EQ. Y(I-1)) .OR. (Y(I) .EQ. Y(I-2))) GOTO 1
      IF (DABS(Y(I)) .LE. 0.0000001) THEN
         GOTO 1
         ELSE
         BN = BNEW(BB,AA,R,K)
         BB = BN
         GOTO 2
      ENDIF
    1 A = SNGL(AA)
      B = SNGL(BB)
      RETURN
      END
C***********************************************************************
C                          FUNCTION CHISQ
C
C     EVALUATE THE PROBABILITY INTEGRAL OF CHI-SQUARE DISTRIBUTION
C***********************************************************************
```

```
      FUNCTION CHISQ(R,X)
      INTEGER R
      DOUBLE PRECISION X,GAM,Y,CHI,P
C     THIS PROCEDURE EVALUATE THE PROBABILITY INTEGRAL
C     OF CHI-SQUARE DISTRIBUTION BASED ON ALGORITHM 299
C     IN CACM ,VOL.10 ,NO.4 ,APRIL ,1967 BY I.D. HILL
C     AND M.C. PIKE
C
      DIMENSION CHI(100)
      CHI(1) = 1.- GAUSS(DSQRT(X))*2
      CHI(2) = DEXP(-X/2)
      DO 10 I = 3,R
      IF (2*(I/2) .EQ. I)THEN
      M = I/2 - 1
      CALL FAC(M,GAM)
      ELSE
      CALL TALL(I,GAM)
      ENDIF
      Y = (((X/2.)**(I/2.-1.))*DEXP(-X/2.))/GAM
      CHI(I) = CHI(I-2.) + Y
   10 CONTINUE
      P = CHI(R)
      CHISQ = 1-P
      RETURN
      END
```

```
C***********************************************************************
C                          SUBROUTINE FAC
C
C     EVALUATE THE GAMMA FUNCTION FOR INTEGER VALUE
C***********************************************************************
      SUBROUTINE FAC(N,GAM)
      DOUBLE PRECISION GAM
      IF ((N.EQ.0).OR.(N.EQ.1)) THEN
      GAM = 1
      GOTO 20
      ENDIF
      GAM = 1
      DO 10 I = 2,N
      GAM = I*GAM
   10 CONTINUE
   20 RETURN
      END
C***********************************************************************
C                          SUBROUTINE TALL
C
C     EVALUATE THE GAMMA FUNCTION FOR FRACTION VALUE
C***********************************************************************
      SUBROUTINE TALL(N,GAM)
      DOUBLE PRECISION VT,VT1,GAM
      DIMENSION VT(100)
      IF (N/2. .EQ. 0.5) THEN
```

```
      GAM = SQRT(22/7.)
      GOTO 20
      ENDIF
      M = N/2
      VT1 = 1
      DO 10 I = 1,M
      VT(I) = (N-2*I)/2.
      VT1 = VT1*VT(I)
   10 CONTINUE
      GAM = VT1*SQRT(22/7.)
   20 RETURN
      END
C***********************************************************************
C                           FUNCTION GAUSS
C
C     EVALUATE THE PROBABILITY INTEGRAL OF STANDARD NORMAL
C     DISTRIBUTION
C***********************************************************************
      FUNCTION GAUSS(X)
      DOUBLE PRECISION X,Z,Y,W
      IF (X .EQ. 0) THEN
      Z = 0
        ELSE
        Y = DABS(X)/2.
        IF (Y .GE. 3.) THEN
        Z = 1.
```

```
      ELSE
      IF (Y .LT. 1.) THEN
         W = Y*Y
         Z = ((((((((0.000124818987*W
     *        -0.001075204047)*W+0.005198775019)*W
     *        -0.019198292004)*W+0.059054035642)*W
     *        -0.151968751364)*W+0.319152932694)*W
     *        -0.531923007300)*W+0.797884560593)*Y*2.
       ELSE
         Y = Y-2.
         Z = (((((((((((((-0.000045255659*Y
     *        +0.000152529290)*Y-0.000019538132)*Y
     *        -0.000676904986)*Y+0.001390604284)*Y
     *        -0.000794620820)*Y-0.002034254874)*Y
     *        +0.006549791214)*Y-0.010557625006)*Y
     *        +0.011630447319)*Y-0.009279453341)*Y
     *        +0.005353579108)*Y-0.002141268741)*Y
     *        +0.000535310849)*Y+0.999936657524
       ENDIF
    ENDIF
 ENDIF
 IF (X .GT. 0.) THEN
    GAUSS = (Z+1.)/2.-0.5
    ELSE
    GAUSS = (1.-Z)/2.-0.5
 ENDIF
```

```
      RETURN
      END
C**************************************************************************
C                 FUNCTION BNEW
C
C     EVALUATE BNEW BY NEWTON-RAPHSON METHOD
C**************************************************************************
      FUNCTION BNEW(BB,AA,R,K)
      INTEGER R
      DOUBLE PRECISION BB,AA,Y,YPRIME,RATE
   17 Y = (AA**((R+K)/2.))*DEXP(-AA/2.)-(BB**((R+K)/2.))
     *    *DEXP(-BB/2.)
      YPRIME = -(((R+K)/2.)*BB**((R+K)/2.-1)*DEXP(-BB/2.)+
     *     (-0.5)*BB**((R+K)/2.)*DEXP(-BB/2.))
      BNEW = BB-Y/YPRIME
      RATE = (BNEW-BB)
      IF (DABS(RATE) .LE. 0.000001) THEN
      GOTO 16
      ELSE
      BB = BNEW
      GOTO 17
      ENDIF
   16 RETURN
      END
```

```
C*********************************************************************
C                     FUNCTION VCHI2
C
C      EVALUATE THE PERCENTAGE POINTS OF THE CHI-SQUARED
C*********************************************************************
       FUNCTION VCHI2(PHI,V)
       DOUBLE PRECISION PHI,E,AA,XX,C,CH,A,Q,P1,P2,T,X,B,S1
     * ,S2,S3,S4,S5,S6
C
C      EVALUATE THE PERCENTAGE POINTS OF THE CHI-SQUARED
C      PROBABILITY DISTRIBUTION FUNCTION.
C      SLOW BUT ACCURATE INVERSION OF CHI-SQUARED CDF.
C
C      BASES ON ALGORITHM AS 91 APPL.STATIST.(1975)
C      VOL.24 , NO.3
C
C      INPUTS:
C      PHI = PROBABILITY TO BE INVERTED.
C      PHI SHOULD LIE IN THE RANGE 0.000002 TO 0.999998,
C      V = DEGREES OF FREEDOM, AND MUST BE POSITIVE,
C
C      OUTPUT :
C      VCHI2 = INVERSE OF CHI-SQUARE CDF OF PHI
C
C      AUXILIARY ROUTINES:
C      VNORM, GAMAIN
```

```
C
C     DESIRED ACCURACY AND LN(2.):
C
      DATA E, AA/0.5D-5,0.6931471805D0/
C
C     DATE 10 SEPT 1986.
C
C     CHECK FOR UNUSUAL INPUT
C
      IF (V .LE. 0.) GOTO 9000
      IF (PHI .LE. 0.000002 .OR. PHI .GE. 0.999998) GOTO 9000
      IFAULT = 0
C
C     IFAULT = 4 IF INPUT ERROR,ELSE 0
C
      G = ALOGAM(V/2.)
C
C     G MUST BE SUPPLIED AND SHOULD BE EQUAL TO LN(GAMMA(V/2.0))
C     E.G. USING FUNCTION ALOGAM.
C
      XX = 0.5*V
      C = XX - 1.0
C
C     STARTING APPROXIMATION FOR SMALL CHI-SQUARED.
C
      IF(V .GE. -1.24 * DLOG(PHI)) GOTO 1
```

```
      CH = (PHI*XX*DEXP(G+XX*AA))**(1.0/XX)
      IF (CH - E) 6,4,4
C
C     STARTING APPROXIMATION FOR V LESS THAN OR EQUAL TO 0.32
C
    1 IF (V .GT. 0.32) GOTO 3
      CH = 0.4
      A = DLOG(1.0-PHI)
    2 Q = CH
      P1 = 1.0+CH*(4.67+CH)
      P2 = CH*(6.73+CH*(6.66+CH))
      T = -0.5+(4.67+2.0*CH)/P1-
     *    (6.73+CH*(13.32+3.0*CH))/P2
      CH = CH - (1.0-DEXP(A+G+0.5*CH+C*AA)*P2/P1)/T
      IF (DABS(Q/CH-1.0)-0.01) 4,4,2
C
C     GET THE CORRESPONDING NORMAL DEVIATE:
C
    3 x =  VNORM(PHI,IFAULT)
C
C     STARTING APPROXIMATION USING WILSON AND HILFERTY ESTIMATE
C
      P1 = 0.222222/V
      CH = V*(X*DSQRT(P1)+1.0-P1)**3
C     STARTING APPROXIMATION FOR P TENDING TO 1
C
```

```
      IF (CH .GT. 2.2*V+6.0)
     * CH = -2.0*(DLOG(1.0-PHI)-C*DLOG(0.5*CH)+G)
C
C     CALL TO ALGORITHM AS 32 AND CALCULATION OF SEVEN TERM
C     TAYLOR SERIES.
C
    4 Q = CH
      P1 = 0.5*CH
      P2 = PHI-GAMAIN(P1,XX,G,IF1)
      IF (IF1 .EQ. 0 ) GOTO 5
      IFAULT = 4
      RETURN
    5 T = P2*DEXP(XX*AA+G+P1-C*DLOG(CH))
      B = T/CH
      A = 0.5*T-B*C
      S1 = (210.0+A*(140.0+A*(105.0+A*(84.0+A*(70.0+60.0*A)))))
     *     /420.0
      S2 = (420.0+A*(735.0+A*(966.0+A*(1141.0+1278.0*A))))
     *     /2520.0
      S3 = (210.0+A*(462.0+A*(707.0+932.0*A)))/2520.0
      S4 = (252.0+A*(672.0+1182.0*A)+C*(294.0+A*(889.0+1740.0*A)
     *    ))/5040.0
      S5 = (84.0+264.0*A+C*(175.0+606.0*A))/2520.0
      S6 = (120.0+C*(360.0+127.0*C))/5040.0
      CH = CH+T*(1.0+0.5*T*S1-B*C*(S1-B*(S2-B*(S3-B*(S4-B*(S5-
     *     B*S6))))))
```

```
      IF (DABS(Q/CH-1.0) .GT. E) GOTO 4
    6 VCHI2 = CH
      RETURN
 9000 IFAULT = 4
C
C     TRY TO GIVE SENSIBLE RESPONSE
C
      VCHI2 = 0.
      IF (PHI .GT. 0.999998) VCHI2 = V+4.*DSQRT(2.*V)
      RETURN
      END
C***********************************************************************
C                          FUNCTION VNORM
C
C     EVALUATE THE INVERSE OF THE CDF OF THE NORMAL DISTRIBUTION
C***********************************************************************
      FUNCTION VNORM(PHI,IFAULT)
      DOUBLE PRECISION PHI,PLIM,P0,P1,P2,P3,P4
     * ,Q0,Q1,Q2,Q3,Q4,P,VTEMP
C
C     VNORM RETURNS THE INVERSE OF THE CDF OF THE NORMAL
C     DISTRIBUTION.
C     IT USES A RATIONAL APPROXIMATION WHICH SEEMS TO HAVE A
C     RELATIVE
C     ACCURACY OF ABOUT 5 DECIMAL PLACES.
C     REF.:DENNEDY AND GENTLE,STATISTICAL COMPUTING,DEKKER,1980.
```

```
C
C     INPUT:
C     PHI = PROBABILITY,0 <= PHI <= 1.
C
C     OUTPUT:
C     F INVERSE OF PHI, I.E., A VALUE SUCH THAI
C     PROB(X <= VNORM) = PHI.
C     IFAULT = 6 IF PHI OUT OF RANGE,ELSE 0
C
      DATA PLIM /1.0D-18/
      DATA P0/-0.322232431088D0/,P1/-1.0/,P2/-0.342242088547D0/
      DATA P3 / -0.0204231210245D0/, P4/-0.453642210148D-4/
      DATA Q0/0.099348462606D0/, Q1/0.588581570495D0/
      DATA Q2/0.531103462366D0/,Q3/0.10353775285D0/
      DATA Q4/0.38560700634D-2/
      IFAULT = 0
      P = PHI
      IF (P .GT. 0.5) P = 1.-P
      IF (P .GE. PLIM) GOTO 100
C
C     THIS IS AS FAR OUT IN THE TAILS AS WE GO
C
      VTEMP = 8.
C
C     CHECK FOR INPUT ERROR
C
```

```
      IF (P .LT. 0.) GOTO 9000
      GOTO 200
  100 Y = DSQRT(-DLOG(P*P))
      VTEMP = Y + ((((Y*P4+P3)*Y+P2)*Y+P1)*Y+P0)/
     *        ((((Y*Q4+Q3)*Y+Q2)*Y+Q1)*Y+Q0)
  200 IF (PHI .LT. 0.5) VTEMP = -VTEMP
      VNORM = VTEMP
      RETURN
 9000 IFAULT = 6
      RETURN
      END
C************************************************************************
C                             FUNCTION GAMAIN
C************************************************************************
      FUNCTION GAMAIN(X,P,G,IFAULT)
      DOUBLE PRECISION X,P,PN,ACU,OFLO,GIN,FACTOR
     * ,TERM,RN,A,B,AN,DIF
C
C     ALGORITHM AS 32 J.R.STATIST.SOC. C.(1970) VOL.19 NO.3
C
C     COMPUTES INCOMPLETE GAMMA RATIO FOR POSITIVE VALUES OF
C     ARGUMENTS X AND P. G MUST BE SUPPLIED AND SHOULD BE
C     EQUAL TO LN(GAMMA(P)).
C     IFAULT = 1 IF P.LE.0 ELSE 2 IF X.LT.0 ELSE 0.
C     USES SERIES EXPANSION IF P.GT.X OR X.LE.1,
C     OTHERWISE A CONTINUED FRACTION APPROXIMATION.
```

```
C
      DIMENSION PN(6)
C
C     DEFINE ACCURACY AND INITIALIZE
C
      DATA ACU/1.D-8/,OFLO/1.D30/
      GIN =0.0
      IFAULT = 0
C
C     TEST FOR ADMISSIBILITY OF ARGUMENTS
C
      IF (P.LE.0.0) IFAULT = 1
      IF(X.LT.0.0) IFAULT = 2
      IF(IFAULT.GT.0.0.OR.X.EQ.0.0) GOTO 50
      FACTOR=DEXP(P*DLOG(X)-X-G)
      IF(X.GT.1.0.AND.X.GE.P) GOTO 30
C
C     CALCYLATION BY SERIES EXPANSION
C
      GIN=1.0
      TERM=1.0
      RN=P
   20 RN=RN+1.0
      TERM=TERM*X/RN
      GIN=GIN+TERM
      IF(TERM.GT.ACU) GOTO 20
```

```
      GIN=GIN*FACTOR/P
      GOTO 50
C
C     CALCULATION BY CONTINUED FRACTION
C
   30 A=1.0-P
      B=A+X+1.0
      TERM=0.0
      PN(1)=1.0
      PN(2)=X
      PN(3)=X+1.0
      PN(4)=X*B
      GIN=PN(3)/PN(4)
   32 A=A+1.0
      B=B+2.0
      TERM = TERM+1.0
      AN=A*TERM
      DO 33 I=1,2
   33 PN(I+4)=B*PN(I+2)-AN*PN(I)
      IF(PN(6).EQ.0.0) GOTO 35
      RN=PN(5)/PN(6)
      DIF=DABS(GIN-RN)
      IF(DIF.GT.ACU) GOTO 34
      IF(DIF.LE.ACU*RN) GOTO 42
   34 GIN=RN
   35 DO 36 I=1,4
```

```
   36 PN(I)=PN(I+2)
      IF(DABS(PN(5)).LT.OFLO) GOTO 32
      DO 41 I=1,4
   41 PN(I)=PN(I)/OFLO
      GOTO 32
   42 GIN=1.0-FACTOR*GIN
   50 GAMAIN = GIN
      RETURN
      END
C***********************************************************************
C                          FUNCTION ALOGAM
C***********************************************************************
      FUNCTION ALOGAM(Y)
      DOUBLE PRECISION  X,F,Z
C
C     THIS PROCEDURE EVALUATES THE NATURAL LOGARITHM OF GAMMA(Y)
C     FOR ALL Y GT 0, ACCURATE TO APPROXIMATELY MACHINE
C     PRECISION OR 10 DECIMAL DEGITS,WHICH EVER IS LESS.
C     STIRLING'S FORMULA IS USED FOR THE CENTRAL POLYNOMIAL
C     PART OF THE PROCEDURE.
C     BASED ON ALG. 291 IN CACM, VOL. 9, NO. 9 SEPT. 66, P.384,
C     BY M.C. PIKE AND I.D. HILL.
C
      X = Y
      IF(X.GE.7.0) GOTO 20
      F=1.0
```

```
      Z=X-1.0
      GOTO 7
    5 X=Z
      F=F*Z
    7 Z=Z+1.
      IF(Z .LT. 7) GOTO 5
      X=X+1.
      F=-DLOG(F)
      GOTO 30
   20 F=0.
   30 Z=(1.0/X)**2.0
      ALOGAM = F+(X-0.5)*DLOG(X)-X+0.918938533204673+
     *          (((-0.000595238095238*Z+0.000793650793651)*Z-
     *          0.002777777777778)*Z+0.083333333333333)/X
      RETURN
      END
C**************************************************************************
```

ภาคผนวก ข.

ตารางที่ ข.1 แสดงค่าตัวหารสำหรับช่วงความเชื่อมั่น สำหรับความแปรปรวนของการแจกแจงแบบปกติ โดยวิธีช่วงความเชื่อมั่นที่สั้นที่สุด ที่ค่าสัมประสิทธิ์ความเชื่อมั่น 0.90, 0.95, 0.99 และ 0.995 องศาอิสระ เป็น 1 ถึง 7

ถ้า $X_1,...,X_n$ เป็นตัวอย่างสุ่มขนาด n จาก $N(\mu,\sigma^2)$ ให้ $\bar{X} = (1/n)\sum_{i=1}^{n} X_i$ และ $s^2 = [\sum_{i=1}^{n}(x_i-\bar{X})^2]/(n-1)$ ช่วงความเชื่อมั่น $(1-\alpha)100\%$ สำหรับ σ^2 โดยวิธีช่วงความเชื่อมั่นที่สั้นที่สุดกำหนดโดย $[(n-1)s^2/b_{ML},(n-1)s^2/a_{ML})]$ ค่าในตารางตัวเลขบนคือค่า a_{ML} ตัวเลขล่างคือค่า b_{ML} เมื่อองศาอิสระ r เท่ากับ n-1 และสัมประสิทธิ์ความเชื่อมั่น เท่ากับ $1-\alpha$

$1-\alpha$ / r	.9000	.9500	.9900	.9950
1	.0158 21.6918	0.00393 26.4448	.000157 37.1186	.0000393 41.6210
2	.2105 18.0077	.1025 21.4812	.0201 29.1361	0.01002 32.3239
3	.5821 17.6381	.3513 20.7438	.1148 27.5107	.0717 30.3027
4	1.0561 18.1062	.7083 21.0631	.2969 27.4603	.2069 30.0844
5	1.5938 18.9081	1.1393 21.8001	.5534 28.0269	.4113 30.5698
6	2.1751 19.8739	1.6233 22.7410	.8700 28.8927	.6747 31.3964
7	2.7883 20.9302	2.1473 23.7943	1.2350 29.9229	.9871 32.4104

ตารางที่ ข.2 แสดงค่าตัวหารสำหรับช่วงความเชื่อมั่น สำหรับความแปรปรวนของการแจกแจงแบบปกติ โดยวิธีช่วงความเชื่อมั่นที่สั้นที่สุด ที่ค่าสัมประสิทธิ์ความเชื่อมั่น 0.90, 0.95, 0.99 และ 0.995 องศาอิสระ เป็น 8 ถึง 16

r \ $1-\alpha$	.9000	.9500	.9900	.9950
8	3.4262 22.0405	2.7027 24.9147	1.6397 31.0506	1.3406 33.5356
9	4.0840 23.1843	3.2836 26.0769	2.0775 32.2397	1.7288 34.7308
10	4.7584 24.3498	3.8855 27.2662	2.5435 33.4684	2.1469 35.9712
11	5.4467 25.5293	4.5055 28.4732	3.0335 34.7240	2.5908 37.2419
12	6.1472 26.7180	5.1409 29.6920	3.5447 35.9962	3.0573 38.5330
13	6.8583 27.9126	5.7899 30.9184	4.0744 37.2808	3.5439 39.8377
14	7.5788 29.1109	6.4510 32.1498	4.6206 38.5732	4.0483 41.1517
15	8.3079 30.3111	7.1228 33.3840	5.1816 39.8716	4.5689 42.4732
16	9.0446 31.5125	7.8043 34.6197	5.7559 41.1709	5.1040 43.7950

ตารางที่ ข.3 แสดงค่าตัวหารสำหรับช่วงความเชื่อมั่น สำหรับความแปรปรวนของการแจกแจงแบบปกติ โดยวิธีช่วงความเชื่อมั่นที่สั้นที่สุด ที่ค่าสัมประสิทธิ์ความเชื่อมั่น 0.90, 0.95, 0.99 และ 0.995 องศาอิสระ เป็น 17 ถึง 24

r \ $1-\alpha$	.9000	.9500	.9900	.9950
17	9.7884 32.7138	8.4948 35.8559	6.3425 42.4726	5.6523 45.1204
18	10.5385 33.9148	9.1932 37.0919	6.9402 43.7748	6.2128 46.4465
19	11.2947 35.1147	9.8991 38.3270	7.5481 45.0764	6.7846 47.7723
20	12.0563 36.3137	10.6119 39.5610	8.1655 46.3771	7.3666 49.0973
21	12.8231 37.5110	11.3311 40.7934	8.7916 47.6762	7.9582 50.4217
22	13.5946 38.7069	12.0562 42.0243	9.4259 48.9736	8.5588 51.7424
23	14.3706 39.9010	12.7869 43.2532	10.0679 50.2688	9.1677 53.0617
24	15.1508 41.0935	13.5227 44.4802	10.7169 51.5618	9.7845 54.3793

ตารางที่ ข.4 แสดงค่าตัวหารสำหรับช่วงความเชื่อมั่น สำหรับความแปรปรวนของการแจกแจงแบบปกติ โดยวิธีช่วงความเชื่อมั่นที่สั้นที่สุด ที่ค่าสัมประสิทธิ์ความเชื่อมั่น 0.90, 0.95, 0.99 และ 0.995 องศาอิสระ เป็น 25 ถึง 33

r \ 1-α	.9000	.9500	.9900	.9950
25	15.9351 42.2839	14.2636 45.7051	11.3727 52.8524	10.4086 55.6940
26	16.7230 43.4728	15.0090 46.9281	12.0348 54.1407	11.0397 57.0063
27	17.5147 44.6595	15.7589 48.1490	12.7024 55.4277	11.6764 58.3186
28	18.3095 45.8447	16.5128 49.3675	13.3767 56.7096	12.3211 59.6229
29	19.1077 47.0276	17.2708 50.5843	14.0559 57.9914	12.9699 60.9295
30	19.9088 48.2092	18.0324 51.7986	14.7401 59.2682	13.6261 62.2286
31	20.7131 49.3885	18.7977 53.0108	15.4292 60.5436	14.2867 63.5273
32	21.5199 50.5665	19.5663 54.2213	16.1228 61.8166	14.9524 64.8236
33	22.3296 51.7423	20.3384 55.4294	16.8210 63.0870	15.6229 66.1169

ตารางที่ ข.5 แสดงค่าตัวหารสำหรับช่วงความเชื่อมั่น สำหรับความแปรปรวนของการแจกแจงแบบปกติ โดยวิธีช่วงความเชื่อมั่นที่สั้นที่สุด ที่ค่าสัมประสิทธิ์ความเชื่อมั่น 0.90, 0.95, 0.99 และ 0.995 องศาอิสระ เป็น 34 ถึง 42

r \ 1-α	.9000	.9500	.9900	.9950
34	23.1417 52.9167	21.1134 56.6359	17.5234 64.3551	16.2981 67.4078
35	23.9564 54.0891	21.8915 57.8401	18.2298 65.6206	16.9777 68.6959
36	24.7733 55.2602	22.6724 59.0427	18.9401 66.8838	17.6615 69.9816
37	25.5927 56.4292	23.4562 60.2431	19.6541 68.1445	18.3495 71.2646
38	26.4140 57.5972	24.2424 61.4421	20.3717 69.4031	19.0413 72.5454
39	27.2377 58.7631	25.0315 62.6387	21.0928 70.6592	19.7370 73.8235
40	28.0631 59.9280	25.8227 63.8341	21.8171 71.9133	20.4362 75.0994
41	28.8909 61.0908	26.6166 65.0273	22.5448 73.1649	21.1390 76.3727
42	29.7201 62.2528	27.4126 66.2192	23.2754 74.4148	21.8451 77.6440

ตารางที่ ข.6 แสดงค่าตัวหารสำหรับช่วงความเชื่อมั่น สำหรับความแปรปรวนของการแจกแจงแบบปกติ โดยวิธีช่วงความเชื่อมั่นที่สั้นที่สุด ที่ค่าสัมประสิทธิ์ความเชื่อมั่น 0.90, 0.95, 0.99 และ 0.995 องศาอิสระ เป็น 43 ถึง 49

r \ $1-\alpha$	.9000	.9500	.9900	.9950
43	30.5516 63.4128	28.2110 67.4090	24.0091 75.6621	22.5546 78.9127
44	31.3845 64.5719	29.0113 68.5977	24.7456 76.9077	23.2672 80.1795
45	32.2195 65.7291	29.8140 69.7843	25.4850 78.1510	23.9829 81.4439
46	33.0557 66.8855	30.6184 70.9697	26.2270 79.3926	24.7014 82.7063
47	33.8940 68.0401	31.4250 72.1532	26.9717 80.6320	25.4229 83.9664
48	34.7335 69.1940	32.2333 73.3357	27.7188 81.8698	26.1471 85.2248
49	35.5748 70.3460	33.0436 74.5162	28.4685 83.1054	26.8741 86.4808

ประวัติผู้เขียน

นางสาวภรมนัส ประยูรรัตน เกิดเมื่อวันที่ 19 กุมภาพันธ์ พ.ศ. 2511 จังหวัดกรุงเทพฯ สำเร็จการศึกษาระดับปริญญาตรี วิทยาศาสตร์บัณฑิต (สถิติ) ภาควิชาสถิติ คณะวิทยาศาสตร์ มหาวิทยาลัยเกษตรศาสตร์ เมื่อปีการศึกษา 2532 และเข้าศึกษาต่อในระดับปริญญาโท หลักสูตรสถิติศาสตรมหาบัณฑิต ภาควิชาสถิติ คณะพาณิชยศาสตร์และการบัญชี จุฬาลงกรณ์มหาวิทยาลัย เมื่อปีการศึกษา 2533