รายการอ้างอิง

ภาษาไทย

จงดี โรจนประศาสน์. **การเปรียบเทียบวิธีการประมาณค่าพารามิเตอร์ในแบบการถดถอยเชิงเส้นอย่างง่ายเมื่อตัวแปรตามมีค่าที่ถูกตัดทิ้ง.** วิทยานิพนธ์ปริญญามหาบัณฑิต ภาควิชาสถิติ บัณฑิตวิทยาลัยจุฬาลงกรณ์มหาวิทยาลัย

ชิดาเดียว มยุรีสวรรค์. **การเปรียบเทียบวิธีการประมาณช่วงความเชื่อมั่นสำหรับค่าสัดส่วนประชากร.** วิทยานิพนธ์ปริญญามหาบัณฑิต ภาควิชาสถิติ บัณฑิตวิทยาลัย-จุฬาลงกรณ์มหาวิทยาลัย

ธีระพร วีระถาวร. **การอนุมานเชิงสถิติขั้นกลาง โครงสร้างและความหมาย** , กรุงเทพมหานคร : พิทักษ์การพิมพ์ , 2531

ประชุม สุวัตถี. **ทฤษฎีการอนุมานเชิงสถิติ** , กรุงเทพมหานคร : สำนักพิมพ์โอเดียนสโตร์ , 2527

ภาษาอังกฤษ

Connover,W.J. **Practical Nonparametric Statistics** , 2 nd edition , New York : John Wiley&Sons , 1980

Cox,D.R. and Oakes,D. **Analysis of Survival Data** , Great Britain : University Printing House,Cambridge , 1985

Elisa,T.Lee **Statistical Methods for Survival Data Analysis** , California : Wadsworth , 1980

Gerald,J.Hahn and William,Q.Meeker **Statistical Intervals** , New York : John Wiley&Sons , 1991

Gillespie,M.J. and Fisher,L. "Confidence bands for the Kaplan Meier Survival Curve Estimate." **Annals of Statistics** , 7 , 1979 , 920-924

Hall,W.J. and Wellner,J.A. "Confidence bands for a survival curve from censored data." **Biometrika** , 67 , 1980 , 133-143

Lawless,J.F. **Statistical Models and Methods for Lifetime Data** , New York : John Wiley&Sons , 1982

Miller,R.G. **Survival Analysis** , New York : John Wiley&Sons , 1981

Nair,V.N. "Confidence bands for survival function with censored data." **Technometrics** , 26 , 1984 , 265-275

_____ "Plots and tests for goodness of fit with randomly censored data." **Biometrika** , 68 , 1981 , 99-103

Peter,J.Bickel and Kjell,A.Doksum **Mathematical Statistics** , U.S.A. : Holden-Day , 1977

Thomas,D.R. and Grunkemeier,G.L. " Confidence interval estimation of survival probabilities for censored data." **Journal of the American Statistical Association** , 70 , 1975 , 865-871

ภาคผนวก

ภาคผนวก ก.

ตัวประมาณพีแอล (PL Estimator)

$$\hat{q}_i = \frac{d_i}{n_i}$$

$$\hat{p}_i = 1-\hat{q}_i = \begin{cases} 1-\frac{1}{n_i} & \delta_i = 1 \quad \text{ข้อมูลที่ไม่ถูกตัดทิ้ง} \\ 1 & \delta_i = 0 \quad \text{ข้อมูลที่ถูกตัดทิ้ง} \end{cases}$$

$$\hat{S}(t) = \prod_{(i:t_i \le t)} \hat{p}_i = \prod_{(i:t_i \le t)} (1-\frac{1}{n_i})^{\delta_i}$$

$$= \prod_{(i:t_i \le t)} (1-\frac{1}{n-i+1})^{\delta_i}$$

$$= \prod_{(i:t_i \le t)} (\frac{n-i}{n-i+1})^{\delta_i}$$

ความแปรปรวนของ $\hat{S}(t)$

จาก $\hat{S}(t) = \prod_{(i:t_i \le t)} \hat{p}_i$ จะได้ $\log(\hat{S}(t)) = \sum_{(i:t_i \le t)} \log(\hat{p}_i)$

โดยที่ $Var(\hat{p}_i) = \frac{p_i q_i}{n_i}$

จากสูตรของความแปรปรวนของฟังก์ชัน $g(x)$

$$Var(g(x)) = (g'(m))^2 Var(x)$$

โดยที่ $m = E[X]$

พิสูจน์ได้โดยกำหนดให้ $y = g(x)$ และ $m = E[X]$

$g(x)$ เขียนในรูปอนุกรม Taylor ได้ดังนี้

$$g(x) = g(m)+(x-m)g'(m)+\frac{1}{2}(x-m)^2 g''(m)+.....$$

$$E[y] = E[g(x)] \approx g(m)+\frac{1}{2}g''(m)Var(x)$$

เพราะว่า $E[g(m)] = g(m)$ และ $E[x-m] = 0$

$$\begin{aligned} Var[g(x)] &= E\left[\{g(x)-E[g(x)]\}^2\right] \\ &\approx E\left[(x-m)^2[g'(m)]^2\right] \\ &= [g'(m)]^2 Var(x) \end{aligned}$$

ดังนั้น $Var\left(\log(\hat{S}(t))\right) = \sum_{(i:t_i\le t)} \left(\frac{1}{p_i}\right)^2 \left(\frac{p_i q_i}{n_i}\right)$

$$= \sum_{(i:t_i\le t)} \left(\frac{q_i}{p_i n_i}\right)$$

เพราะฉะนั้น

$$Var\left(\hat{S}(t)\right) = \left(S(t)\right)^2 \sum_{(i:t_i\le t)} \left(\frac{q_i}{p_i n_i}\right)$$

เนื่องจากไม่ทราบค่าของ $S(t)$, p_i และ q_i ดังนั้นต้องใช้ตัวประมาณแทน

$$\hat{V}ar\left(\hat{S}(t)\right) = \left(\hat{S}(t)\right)^2 \sum_{(i:t_i\le t)} \left(\frac{\hat{q}_i}{\hat{p}_i n_i}\right)$$

ในทางปฏิบัติสามารถประมาณค่าความแปรปรวนของ $\hat{S}(t)$ ได้โดย (Greenwood's formula)

$$\hat{V}ar\left(\hat{S}(t)\right) = \left(\hat{S}(t)\right)^2 \sum_{(i:t_i\le t)} \frac{\delta_i}{(n-i)(n-i+1)}$$

หรือ $\hat{V}ar\left(\hat{S}(t)\right) = \frac{\hat{S}(t)\hat{\sigma}^2(t)}{n}$

โดยที่ $\hat{\sigma}^2(t) = n \sum_{(i:t_i\le t)} \frac{\delta_i}{(n-i)(n-i+1)}$

กำหนดให้ $\hat{K}(t) = \frac{\hat{\sigma}^2(t)}{1+\hat{\sigma}^2(t)}$ ดังนั้น $0 < \hat{K}(t) < 1$

$$\bar{K}(t) = 1-\hat{K}(t)$$

ในกรณีที่ข้อมูลเป็นแบบสมบูรณ์จะได้ $\hat{K}(t) = \hat{F}(t) = 1-\hat{S}(t)$

ภาคผนวก ข.

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C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     CONFIDENCE BANDS FOR SURVIVAL FUNCTIONS
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      DOUBLE PRECISION PHI,IFAULT,PLIM,P0,P1,P2,P3,P4,
     *         Q0,Q1,Q2,Q3,Q4,P,VTEMP
      DIMENSION X(200),IDX(200),XC(200),XN(200),PL(3),PL1(3),PA0(3),
     *PB1(3),WEN(12,3),WHN(12,3),WRN(12,3),SWE(12,3),SWH(12,3),
     *SWR(12,3),WE(12,3),WH(12,3),WR(12,3),BWE(12,3),BWH(12,3),
     *BWR(12,3),Y(12),WEBD(12,3),WHBD(12,3),WRBD(12,3),SS(12),ELP(3),
     *HLP(3),RLP(3),UEP(3),VEP(3),UHW(3),VHW(3),URN(3),VRN(3)
      COMMON /SEED/IX /SELECT/KK
      REAL NORMAL
      DATA (Y(I),I=1,12) /0.25,0.5,0.75,1.0,1.25,1.5,1.75,2.0,2.25,2.5,
     *2.75,3.0/
      LP = 3
      NP = 12
      N = 25
      NN = 23
      NC = 2
      LO = 2000
      PL(1) = 0.1
      PL(2) = 0.05
      PL(3) = 0.01
      PL1(1) = 0.8890
      PL1(2) = 0.9405
      PL1(3) = 0.9843
      PA0(1) = 2.0
      PA0(2) = 3.0
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```
      PA0(3) = 3.0
      PB1(1) = 3.0
      PB1(2) = 4.0
      PB1(3) = 4.0
      AA = 0.0
      BB = 3.0
      EALP = 0.4
      ALP = 1.0
      GMA = 1.50
      DMEAN = 0.0
      DVARI = 0.7
      SIGMA = SQRT(DVARI)
      AB = 0.30
      AC = 3.50
      IA = 65539
      IX = 173
      KK = 0
      WRITE(6,900) N,NN,NC,LO,IX
  900 FORMAT(20X,' N =',I3,' NN =',I3,' NC =',I3,' LO =',I4,' IX =',I6)
      WRITE(6,910) ALP,GMA,AA,BB
  910 FORMAT(20X,' ALPHA =',F5.2,' GAMA = ',F5.2,' A =',F5.2,' B =',F5.2)
 5000 SIC = 0.0
      DO 91 LI2 = 1,NP
      DO 90 I = 1,LP
       SWE(LI2,I) = 0.0
       SWH(LI2,I) = 0.0
       SWR(LI2,I) = 0.0
       BWE(LI2,I) = 0.0
       BWH(LI2,I) = 0.0
       BWR(LI2,I) = 0.0
```

```
      WEN(LI2,I) = 0.0
      WHN(LI2,I) = 0.0
      WRN(LI2,I) = 0.0
      WE(LI2,I) = 0.0
      WH(LI2,I) = 0.0
      WR(LI2,I) = 0.0
      WEBD(LI2,I) = 0.0
      WHBD(LI2,I) = 0.0
      WRBD(LI2,I) = 0.0
   90 CONTINUE
   91 CONTINUE
      NNLO = 0.0
      DO 50 L = 1,LO
   66 DO 100 I = 1,N
         X(I) = 0.0
         XN(I) = 0.0
         XC(I) = 0.0
         IDX(I) = 0
  100 CONTINUE
         PDL = 0.0
         VRI = 0.0
         VKN = 0.0
         VBKN = 0.0
         UBD = 0.0
         VBD = 0.0
      DO 105 I = 1,LP
         UEP(I) = 0.0
         VEP(I) = 0.0
         UHW(I) = 0.0
         VHW(I) = 0.0
```

```
      URN(I) = 0.0
      VRN(I) = 0.0
      ELP(I) = 0.0
      HLP(I) = 0.0
      RLP(I) = 0.0
  105 CONTINUE
      J5 = 0
      INN = 0
      INC = 0
      DO 120 J1 = 1,N
  109  XN(J1) = WEIBUL(ALP,GMA)
C109  A1 = NORMAL(DMEAN,SIGMA)
C     XN(J1) = EXP(A1)
C109  XN(J1) = GOMPT(AB,AC)
      XC(J1) = UNI(AA,BB)
C     XC(J1) = CEXPO(BALP)
      X(J1) = AMIN1(XN(J1),XC(J1))
      IF (X(J1) .EQ. XN(J1)) THEN
       INN = INN+1
       IDX(J1) = 1
      ELSE
       INC = INC+1
       IDX(J1) = 0
      ENDIF
      IF (INN .EQ. NN) GOTO 121
      IF (INC .EQ. NC) GOTO 122
  120 CONTINUE
      GOTO 132
  121 NC1 = NC-INC
      IF (NC1 .EQ. 0) GOTO 132
```

```
      DO 128 J2 = 1,NC1
         J3 = J1+J2
  124  XN(J3) = WEIBUL(ALP,GMA)
C124   A1 = NORMAL(DMEAN,SIGMA)
C      XN(J3) = EXP(A1)
C124   XN(J3) = GOMPT(AB,AC)
       XC(J3) = UNI(AA,BB)
C      XC(J3) = CEXPO(EALP)
       X(J3) = AMIN1(XN(J3),XC(J3))
       IF (X(J3) .EQ. XN(J3)) GOTO 124
       IDX(J3) = 0
  128 CONTINUE
  122 NN1 = NN-INN
      IF (NN1 .EQ. 0) GOTO 132
      DO 129 J2 = 1,NN1
         J3 = J1+J2
  126  XN(J3) = WEIBUL(ALP,GMA)
C126   A1 = NORMAL(DMEAN,SIGMA)
C      XN(J3) = EXP(A1)
C126   XN(J3) = GOMPT(AB,AC)
       XC(J3) = UNI(AA,BB)
C      XC(J3) = CEXPO(EALP)
      X(J3) = AMIN1(XN(J3),XC(J3))
      IF (X(J3) .EQ. XN(J3)) GOTO 126
      IDX(J3) = 1
  129 CONTINUE
  132 CALL RANK(N,X,IDX)
      DO 5 LI = 1,NP
      SS(LI) = 0.0
      XS = Y(LI)
```

```
      CALL SURLNR(XS,SUW,ALP,GMA)
      SS(LI) = SUW
      CALL PROLM(N,X,IDX,XS,PDL)
      CALL VARIAN(N,X,IDX,XS,VRI,VKN,VBKN)
      CALL CVARIA(N,X,IDX,VKNT)
      DO 150 I = 1,LP
      CALL CVALEP(PA0(I),PB1(I),PL(I),VKNT,ELP(I))
      CALL CVALHW(PL(I),HLP(I))
      CALL CVALRN(PL(I),VKNT,RLP(I))
      CALL EPBAND(N,ELP(I),PDL,VRI,UEP(I),VEP(I))
      CALL HWBAND(N,HLP(I),PDL,VBKN,UHW(I),VHW(I))
      CALL RNBAND(N,RLP(I),PDL,URN(I),VRN(I))
      CALL ERRBD(UEP(I),VEP(I),SUW,WEN(LI,I))
      CALL ERRBD(UHW(I),VHW(I),SUW,WHN(LI,I))
      CALL ERRBD(URN(I),VRN(I),SUW,WRN(LI,I))
      CALL WIDEBD(UEP(I),VEP(I),WEBD(LI,I))
      CALL WIDEBD(UHW(I),VHW(I),WHBD(LI,I))
      CALL WIDEBD(URN(I),VRN(I),WRBD(LI,I))
      SWE(LI,I) = SWE(LI,I) + WEBD(LI,I)
      SWH(LI,I) = SWH(LI,I) + WHBD(LI,I)
      SWR(LI,I) = SWR(LI,I) + WRBD(LI,I)
  150 CONTINUE
    5 CONTINUE
   50 CONTINUE
      WRITE(6,1168)
 1168 FORMAT(/,30X,'**********',/35X,'WEIBULL DIST.
     */30X,'**********')
      DO 180 I = 1,LP
      WRITE(6,1166) PL(I),PL1(I)
 1166 FORMAT(/,30X,'ALPHA = ',F5.2,10X,'LIMIT = ',F6.4)
```

```
      WRITE(6,1165)
 1165 FORMAT(/,20X,' X(I) ',4X,'EP BAND',7X,'HW BAND',7X,'RN BAND')
      DO 160 LI = 1,NP
      WE(LI,I) = WEN(LI,I)/LO
      WH(LI,I) = WHN(LI,I)/LO
      WR(LI,I) = WRN(LI,I)/LO
      WRITE(6,1175) Y(LI),WE(LI,I),WH(LI,I),WR(LI,I)
 1175 FORMAT(20X,F6.3,4X,F7.4,7X,F7.4,7X,F7.4)
       BWE(LI,I) = SWE(LI,I)/LO
       BWH(LI,I) = SWH(LI,I)/LO
       BWR(LI,I) = SWR(LI,I)/LO
      IF (WE(LI,I) .LT. PL1(I)) THEN
       BWE(LI,I) = 0.0
      ENDIF
      IF (WH(LI,I) .LT. PL1(I)) THEN
       BWH(LI,I) = 0.0
      ENDIF
      IF (WR(LI,I) .LT. PL1(I)) THEN
       BWR(LI,I) = 0.0
      ENDIF
  160 CONTINUE
      WRITE(6,1180)
 1180 FORMAT(//5X,' SUR',5X,' X(I)',5X,'WIDE OF EP',5X,'WIDE OF HW',5X,
     *'WIDE OF RN')
      DO 170 LI3 = 1,NP
      WRITE(6,1190) SS(LI3),Y(LI3),BWE(LI3,I),BWH(LI3,I),BWR(LI3,I)
 1190 FORMAT(5X,F7.4,5X,F5.2,3(5X,F10.4))
  170 CONTINUE
  180 CONTINUE
 8000 WRITE(6,3270)
```

```
3270 FORMAT(//30X,'   END  OF JOB   '///)
     STOP
     END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE RANDOM VARIABLE
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
     SUBROUTINE RAND(IX,IY,YFL)
     IY = IX*65539
     IF (IY) 10,20,20
  10 IY = IY + 2147483647 + 1
  20 YFL = IY
     YFL = YFL/2147483647
     IX = IY
     RETURN
     END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C       WEIBULL DISTRIBUTION
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
     FUNCTION WEIBUL(ALP,GMA)
     COMMON /SEED/IX
  10 CALL RAND(IX,IY,YFL)
     IF ((YFL .EQ. 1.0) .OR. (YFL .EQ. 0.0)) GOTO 10
     WEIBUL = (1/ALP)*(-1*(ALOG(1.0-YFL)))**(1.0/GMA)
     RETURN
     END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C       NORMAL  DISTRIBUTION
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
     FUNCTION NORMAL(DMEAN,SIGMA)
     REAL NORMAL
```

```
      COMMON /SEED/IX /SELECT/KK
      PI = 3.1415926
      IF (KK.EQ.1) GOTO 10
        CALL RAND(IX,IY,YFL)
        RONE = YFL
        CALL RAND(IX,IY,YFL)
        RTWO = YFL
        ZONE = SQRT(-2*ALOG(RONE))*COS(2*PI*RTWO)
        ZTWO = SQRT(-2*ALOG(RONE))*SIN(2*PI*RTWO)
        NORMAL = ZONE*SIGMA + DMEAN
        KK = 1
        RETURN
   10 NORMAL = ZTWO*SIGMA + DMEAN
        KK = 0
        RETURN
        END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     GOMPERZT DISTRIBUTION
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      FUNCTION GOMPT(B,C)
      COMMON /SEED/IX
      CALL RAND(IX,IY,YFL)
      GOMPT = (1./ALOG(C))*(ALOG(1.-(ALOG(C)*ALOG(1.-YFL)/B)))
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     UNIFORM DISTRIBUTION
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      FUNCTION UNI(AA,BB)
      COMMON /SEED/IX
```

```
      CALL RAND(IX,IY,YFL)
      UNI = AA+(BB-AA)*YFL
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     EXPONENTIAL DISTRIBUTION
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      FUNCTION CEXPO(EALP)
      COMMON /SEED/IX
      CALL RAND(IX,IY,YFL)
      CEXPO = (-1.0*ALOG(1.0-YFL))/EALP
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  SORTING DATA
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE RANK(N,X,IDX)
      INTEGER N,I,J,SP,MID,LEFT(20),RIGHT(20),IDX(200)
      REAL X(200),PIVOT
      LEFT(1) = 1
      RIGHT(1) = N
      SP = 1
   10 IF (LEFT(SP) .LT. RIGHT(SP)) GOTO 20
        SP = SP-1
        GOTO 130
   20 I = LEFT(SP)
      J = RIGHT(SP)
      PIVOT = X(J)
      MID = (I+J)/2
      IF (J-I .LT. 6) GOTO 50
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```
      IF ((PIVOT .GT. X(I)) .AND. (PIVOT .LT. X(MID))) GOTO 50
      IF ((PIVOT .LT. X(I)) .AND. (PIVOT .GT. X(MID))) GOTO 50
      IF ((X(I) .LT. X(MID)) .AND. (X(I) .GT. PIVOT)) GOTO 30
      IF ((X(I) .GT. X(MID)) .AND. (X(I) .LT. PIVOT)) GOTO 30
       CALL SWAP(X(MID),X(J),IDX(MID),IDX(J))
       GOTO 40
   30 CALL SWAP(X(I),X(J),IDX(I),IDX(J))
   40 PIVOT = X(J)
   50 IF (I .GE. J) GOTO 110
   60  IF (X(I) .GE. PIVOT) GOTO 70
         I = I+1
         GOTO 60
   70 J = J-1
   80 IF (.NOT.((I .LT. J) .AND. (PIVOT .LT. X(J)))) GOTO 90
      J = J-1
      GOTO 80
   90 IF (I .LT. J) CALL SWAP(X(I),X(J),IDX(I),IDX(J))
  100 GOTO 50
  110 J = RIGHT(SP)
      CALL SWAP(X(I),X(J),IDX(I),IDX(J))
      IF ((I-LEFT(SP)) .GE. (RIGHT(SP) - I)) GOTO 120
      LEFT(SP+1) = LEFT(SP)
      RIGHT(SP+1) = I-1
      LEFT(SP) = I+1
      GOTO 125
  120 LEFT(SP+1) = I+1
      RIGHT(SP+1) = RIGHT(SP)
      RIGHT(SP) = I-1
  125 SP = SP+1
  130 IF (SP .GT. 0) GOTO 10
```

```
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE SWAP X(I) WITH X(I+1)
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE SWAP(X1,X2,IDX1,IDX2)
        T = X1
        X1 = X2
        X2 = T
        II = IDX1
        IDX1 = IDX2
        IDX2 = II
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  PRODUCT LIMIT SURVIVAL
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE PROLM(N,X,IDX,XS,PDL)
      DIMENSION X(200),IDX(200)
      REAL NK,NK1
       SURMU = 1.0
       DO 20 K=1,N
        IF (X(K) .GT. XS) GOTO 30
        IF (K .EQ. N) GOTO 30
        NK = N-K
        NK1 = N-K+1
        SX = (NK/NK1)**IDX(K)
        SURMU = SURMU*SX
   20 CONTINUE
   30 PDL = SURMU
```

```
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  SIGMA SQUART WITH CENSORING DATA
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE VARIAN(N,X,IDX,XS,VRI,VKN,VBKN)
      DIMENSION X(200),IDX(200)
      REAL NRR
        SSR = 0
        N1 = N-1
        DO 20 K = 1,N1
         IF (X(K) .GT. XS) GOTO 30
         NRR = (N-K)*(N-K+1)
         SR = IDX(K)/NRR
         SSR = SSR+SR
   20 CONTINUE
   30 VRI = N*SSR
      VKN = VRI/(VRI+1)
      VBKN = 1-VKN
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  SIGMA SQUART WITH COMPLETE DATA
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE CVARIA(N,X,IDX,VKNT)
      DIMENSION X(200),IDX(200)
      REAL NRR
        SSR = 0
        DO 10 I = 1,N
         IF (IDX(I) .EQ. 1) THEN
```

```
        IT = I
       ENDIF
 10    CONTINUE
       N1 = N-1
       DO 20 K = 1,N1
       IF (X(K) .GT. X(IT)) GOTO 30
       NRR = (N-K)*(N-K+1)
       SR = IDX(K)/NRR
       SSR = SSR+SR
 20    CONTINUE
 30    VRI = N*SSR
       VKNT = VRI/(VRI+1)
       RETURN
       END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  CRITICAL VALUE OF EQUAL PRECISION
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
       SUBROUTINE CVALEP(PA0,PB1,PL,VKNT,ELP)
       P0 = PA0
       P1 = PB1
       TOL = 0.0001
       NO = 200
       X1 = 0.95
       X2 = VKNT
       A = 0.05
       B = AMIN1(X1,X2)
       I = 2
       PP = 8*3.141592654
       Q0 = P0*EXP(-1*(P0**2)/2)*ALOG((B**2)/(A**2))/SQRT(PP)-(PL/2)
       Q1 = P1*EXP(-1*(P1**2)/2)*ALOG((B**2)/(A**2))/SQRT(PP)-(PL/2)
```

```
      DO 10 I = 2,NO
        P = P1-(Q1*(P1-P0)/(Q1-Q0))
        FP = P*EXP(-1*(P**2)/2)*ALOG((B**2)/(A**2))/SQRT(PP)-(PL/2)
        IF (ABS(P-P1) .LT. TOL) THEN
        HLP = P
        GOTO 50
        ENDIF
        P0 = P1
        Q0 = Q1
        P1 = P
        Q1 = FP
   10 CONTINUE
      HLP = 0.0
   50 RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  CRITICAL VALUE OF HALL-WELLNER
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE CVALHW(PL,HLP)
      HLP = SQRT((-0.5)*(ALOG(PL)-ALOG(2.0)))
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  CRITICAL VALUE OF RENYI
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE CVALRN(PL,VKNT,RLP)
      DOUBLE PRECISION PHI,IFAULT,PLIM,P0,P1,P2,P3,P4,
     *       Q0,Q1,Q2,Q3,Q4,P,VTEMP
      X1 = 0.8
      X2 = VKNT
```

```
      IFAULT = 0.0
      PHI = (1-PL+3)/4
      WL = VNORM(PHI,IFAULT)
      B = AMIN1(X1,X2)
      RLP = SQRT(B/(1-B))*WL
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     FUNCTION  VALUE OF STANDARD NORMAL
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      FUNCTION CDFN(Z0)
      TLZ0=(1./2.5066282746)*EXP((-1.*(Z0**2)/2.))
      TLWW=1.0/(1.0+0.33267*ABS(Z0))
      TLP=1.0-TLZ0*(0.4361836*TLWW-0.1201676*(TLWW**2)
     *    +0.937298*(TLWW**3))
      IF (Z0.GE.0) THEN
        CDFN=TLP
      ELSE
        CDFN=1.0-TLP
      ENDIF
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     FUNCTION  VALUE OF INVERSE STANDARD NORMAL
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      FUNCTION VNORM(PHI,IFAULT)
      DOUBLE PRECISION PHI,IFAULT,PLIM,P0,P1,P2,P3,P4,
     *       Q0,Q1,Q2,Q3,Q4,P,VTEMP
      DATA PLIM/1.0D-18/
      DATA P0/-0.3222324310245D0/, P1/-1.0/, P2/-0.342242088547D0/
```

```
      DATA P3/-0.0204231210245D0/, P4/-0.43642210148D-4/
      DATA Q0/0.099348462606D0/, Q1/0.588581570495D0/
      DATA Q2/0.53110462366D0/, Q3/0.10353775285D0/
      DATA Q4/0.38560700634D-2/
      IFAULT=0.0
      P=PHI
      IF (P.GT.0.5) P=1-P
      IF (P.GE.PLIM) GOTO 100
      VMTEMP=8.0
      IF (P.LT.0.0) GOTO 900
      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
  900 IFAULT=6
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE EQUAL PRECISION BAND
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE EPBAND(N,ELP,PDL,VRI,UEP,VEP)
      REAL N1
       SEP = 0.0
       N1 = N
       SEP = ELP*PDL*SQRT(VRI)/SQRT(N1)
       UEP = PDL + SEP
       VEP = PDL - SEP
```

```
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  HALL-WELLNER BAND
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE HWBAND(N,HLP,PDL,VBKN,UHW,VHW)
      REAL N1
       SHW = 0.0
       N1 = N
       SHW = HLP*PDL/(SQRT(N1)*VBKN)
       UHW = PDL + SHW
       VHW = PDL - SHW
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  RENYI BAND
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE RNBAND(N,RLP,PDL,URN,VRN)
      REAL N1
      SRN = 0.0
       N1 = N
       SRN = RLP*PDL/SQRT(N1)
       URN = PDL + SRN
       VRN = PDL - SRN
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  SURVIVAL FUNCTION OF WEIBULL
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE SURWEI(XS,SUW,ALP,GMA)
```

```
      SUW = EXP(-1.0*((ALP*XS)**GMA))
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  SURVIVAL FUNCTION OF LOGNORMAL
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE SURLNR(XS,SUW,DMEAN,SIGMA)
      Z0 = (ALOG(XS)-DMEAN)/SIGMA
      SUW = 1-CDFN(Z0)
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  SURVIVAL FUNCTION OF GOMPERZT
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE SURGMT(XS,SUW,B,C)
       A1 = 1.0-C**XS
       A2 = A1*B/ALOG(C)
       SUW = EXP(A2)
      RETURN
      END
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  ERROR OF BAND
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE ERRBD(UBD,VBD,SUW,ENN)
       IF (UBD .LT. SUW) GOTO 30
        IF (VBD .GT. SUW) GOTO 30
      ENN = ENN+1.0
   30 RETURN
      END
```

```
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C     SUBROUTINE  WIDTH OF BAND
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE WIDEBD(UBD,VBD,WBD)
      WBD = UBD-VBD
      RETURN
      END
```

ประวัติผู้เขียน

นายเจษฎา สุทธิอุดม เกิดเมื่อวันที่ 5 ธันวาคม 2514 สำเร็จการศึกษาปริญญาวิทยาศาสตรบัณฑิต (วท.บ.) สาขาสถิติประยุกต์ คณะวิทยาศาสตร์ สถาบันเทคโนโลยีพระจอมเกล้าเจ้าคุณทหารลาดกระบัง ในปีการศึกษา 2535 และเข้าศึกษาต่อในหลักสูตรวิทยาศาสตรมหาบัณฑิต ภาควิชาสถิติ คณะพาณิชยศาสตร์และการบัญชี จุฬาลงกรณ์มหาวิทยาลัย ในปีการศึกษา 2536