

บรรณานุกรม

BOOK

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Article

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C *-----*
C *           THIS PROGRAM TO COMPUTED           *
C * CONTROL LIMIT OF TRACKIN SIGNAL TEST; CUSUM, SMOOTHED *
C * ERROR, AUTOCORRELATION BACKWARD CUSUM *
C *-----*
C *           DESCRIPTION SOME VARIABLE           *
C * ZA(I) = DEPENDENT VARIABLE *
C * I     = INDEPENDENT VARIABLE *
C * E     = ERROR *
C *-----*

DIMENSION ZA(200), SDARLC(1000), SDARLS(1000), SDARLA(1000),
1 SDARLB(1000)
REAL NORMAL, MEAN
COMMON IX
ALPHA = 0.1
GAMMA = 0.05
FIX = 0
WRITE(6,2)ALPHA
2 FORMAT(10X," ALPHA = ", F4.2;//,10X," STEP SIZE ", 5X,
1 " AVERAGE RUN LENGTH " )
W = 0.3
HL = 25.0
HH = 40.0
BSTAR = HL
CCL = 10
CCH = 20
CSTAR = CCL
CSL = 0.1
CSH = 0.5
SSTAR = CSL
CAL = 0.1
CAH = 0.7
ASTAR = CAL

```


C *-----INITIAL VALUE-----*

```

ARLB = 0
ARLC = 0
ARLS = 0
ARLA = 0
MEAN = 0
SD = 1
B0 = 0
B1 = 1
B2 = 0
FLAGC = 0
FLAGS = 0
FLAGA = 0
FLAGB = 0
N = 20
DELTA = 0
SUMZ = 0
SUMBZ = 0
IO = N
SARLC = 0
SARLS = 0
SARLA = 0
SARLB = 0
ZARL = 0
DO 10 I= 1,N
    E = NORMAL(MEAN,SD)
    IF(I.GT.IO) DELTA=1
    ZA(I) = B0 + B1 * I + E
    SUMZ = SUMZ + ZA(I)
    SUMBZ = SUMBZ + ((I - (N + 1)/2) * ZA(I))
10 CONTINUE
ZBAR = SUMZ/N
B1HAT = 12 * SUMBZ/(N ** 3 - N)
BOHAT = ZBAR - B1HAT * ((N + 1)/2)
S01 = BOHAT - ((1 - ALPHA)/ALPHA) * B1HAT
S02 = BOHAT - 2 * ((1 - ALPHA)/ALPHA) * B1HAT

```



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C *-----CASE FIXED VARIANCE-----FIX = 1 -----*
C *-----CASE SMOOTHED VARIANCE-----FIX = 0 -----*
      S1  = S11
      S2  = S21
      H   = HL
      CC  = CCL
      CS  = CSL
      CA  = CAL
      DO 550 J = 1.10
C      B2  = B2 + 0.5
      ARL = 0
      SARL = 0
      M   = 20
      SN  = 0
      IX  = 39567
      DO 100 K = 1.1000
      IF (K.EQ.M) IX = IX + 12.03567
      IF (K.EQ.M.) M = M + 20
      IN  = N + 1
      NL  = 101 + N
      CALL VAR(SD.C1.RMAD.RMSE.SIGMA.ALPHA)
      DO 30 I = IN.NL
          E = NORMAL(MEAN, SD)
          IF(I.GT.I0) DELTA = 1
          Z = B0 + B1 * I + B2 * (I-I0) * DELTA + E
          ZHAT1 = ((2 + ALPHA/(1 - ALPHA) * S11) - ((1 + ALPHA/
1          (1 - ALPHA)) * S21)
          RESID = Z - ZHAT1
          S11 = ALPHA * Z + (1 - ALPHA) * S11
          S21 = ALPHA * S11 + (1 - ALPHA) * S21
          IF(FLAGC.EQ.0)ARLC = CUSUM(RESID.ALPHA.GAMMA.ARLC.CSTAR.
1          RMAD.FIX.C)
          IF(FLAGS.EQ.0)ARLS = SMOOT(RESID.ALPHA.GAMMA.ARLS.SSTAR.
1          RMAD.FIX.S)
          IF(FLAGA.EQ.0)ARLA = AUTO(RESID.ALPHA.GAMMA.ARLA.ASTAR.
1          RMSE.FIX.A)
          IF(FLAGB.EQ.0.AND.FIX.EQ.1)ARLB = BACK(RESID.ALPHA.ARLB.

```

SIGMA. W.DP.DM.BSTAR)

.1
30 CONTINUE

```

      SARLC = SARLC + ARLC
      SARLS = SARLS + ARLS
      SARLA = SARLA + ARLA
      IF(FIX.EQ.1) SARLB = SARLB + ARLB
      SDARLC(K) = ARLC
      SDARLS(K) = ARLS
      SDARLA(K) = ARLA
      IF(FIX.EQ.1) SDARLB(K) = ARLB
      S11 = S1
      S12 = S2
      DP = 0
      DM = 0
      C = 0
      S = 0
      A = 0

```

100 CONTINUE

```

      ZARLC = SARLC/1000
      ZARLS = SARLS/1000
      ZARLA = SARLA/1000
      IF(FIX.EQ.1) ZARLB = SARLB/1000
      DO 150 L = 1,1000
      SSARLC = SSARLC + (SDARLC(L) - ZARLC) ** 2
      SSARLS = SSARLS + (SDARLS(L) - ZARLS) ** 2
      SSARLA = SSARLA + (SDARLA(L) - ZARLA) ** 2
      IF(FIX.EQ.1) SSARLB + (SDARLB(L) - ZARLB) ** 2

```

150 CONTINUE

```

      STDC = SQRT (SSARLC/999)
      STDS = SQRT (SSARLS/999)
      STDA = SQRT (SSARLA/999)
      IF(FIX.EQ.1) STDB = SQRT (SSARLB/999)
      SSARLC = 0
      SSARLS = 0
      SSARLA = 0
      SSARLB = 0
      SARLC = 0

```




```
SARLS      = 0
SARLA      = 0
SARLB      = 0

IF(ZARLC.LT.99.OR.ZARLC.GT.101) CALL CONTR(CCL,CCH,CSTAR,ZARLC)
IF(ZARLS.LT.99.OR.ZARLS.GT.101) CALL CONTR(CSL,CSH,SSTAR,ZARLS)
IF(ZARLA.LT.99.OR.ZARLA.GT.101) CALL CONTR(CAL,CAH,ASTAR,ZARLA)
IF(FIX.EQ1.AND.ZARLB.LT.99.AND.ZARLB.GT.101) CALL CONTR(HL,HH,
1  BSTAR,ZARLB)

IF(ZARLC.GE.99.AND.ZARLC.LE.101)FLAGC = 1
IF(ZARLS.GE.99.AND.ZARLS.LE.101)FLAGL = 1
IF(ZARLA.GE.99.AND.ZARLA.LE.101)FLAGA = 1
IF(ZARLB.GE.99.AND.ZARLB.LE.101)FLAGB = 1

550 CONTINUE
WRITE(6,200) CSTAR,ZARLC,STDC
200 FORMAT(10X," CUSUM ",//,10X," CONTROL LIMIT ",F10.5,//,10X,
1  " AVREAGE RUN LENGTH ", F 6.2,//,10X,STANDARD ERROR ",
1  F 10.7)
WRITE(6,300)SSTAR.ZARLS,STDS
300 FORMAT(10X," SMOOTHED ERROR ",//,10X," CONTROL LIMIT ",F 10.5,
1  //,10X," AVERAGE RUN LENGTH ", F 6.2,//,10X," STANDARD ",
1  " ERROR ", F 10.7)
WRITE(6,400)ASTAR,ZARLA,STDA
400 FORMAT(10X," AUTOCORRELATION ",//,10X," CONTROL LIMIT ",F 10.5,
1  //,10X," AVERAGE RUN LENGTH ",F 6.2,//,10X," STANDARD
1  ERROR ", F 10.7)
WRITE(6,450)BSTAR,ZARLB,STDB
450 FORMAT(10X," BACKWARD CUSUM ",//,10X," CONTROL LIMIT ",F 10.5,
1  //,10X," AVERAGE RUN LENGTH ",F 6.2,//,10X," STANDARD
1  ERROR ",F 10.7)

STOP
END
```

```

SUBROUTINE VAR(SD,C1,RMAD,RMSE,SIGMA,ALPHA)
  IF(ALPHA.EQ.0.1) GOTO 25
  IF(ALPHA.EQ.0.2) GOTO 15
  RMAD = SQRT(1.542 * SD * (2/3.14159))
  RMSE = SQRT(1.542) * SD
  SIGMA= 1.542 * SD
  RETURN
15 RMAD = SQRT(1.293 * SD * (2/3.14159))
  RMSE = SQRT(1.293) * SD
  SIGMA= 1.293 * SD
  RETURN
  RMAD = SQRT(1.135 * SD * (2/3.14159))
  RMSE = SQRT(1.293) * SD
  SIGMA= 1.135 * SD
  RETURN

FUNCTION BACK(RESID,ALPHA,ARLB,SIGMA,W,DP,DM,BSTAR)
  IF(DP.LT.0.OR.DM.GT.0) RETURN
  IF(ARLB.GT.0) GOTO 50
  RLO = SIGMA * W * BSTAR
  DP = RLO
  RML0 = -1 * RLO
  DM = RML0
  ARLB = 0
50 IF(DP.LE.RLO.)DP = DP + (SIGMA * W) - RESID
  IF(DP.GT.RLO.)DP = RLO + (SIGMA * W) - RESID
  IF(DM.LE.RML0)DM = RML0 -(SIGMA * W)-RESID
  IF(DM.GT.RML0)DM = DM - (SIGMA * W) - RESID
  IF(DP.GE.0AND.DM.LE.0)ARLB + 1
  RETURN
END

FUNTION CUSUM (RESID,ALPHA,GAMMA,ARLC,CSTAR,RMAD,FIX,C)
  IF(C.GT.CSTAR) RETURN
  IF(ARLC.GT.0) GOTO 50
  C = 0
  SUMC = 0

```



```

RMADC = RMAD
IF(FIX.EQ.1) GOTO 60
50 RMADC = GAMMA * ABS(RESID) + (1-GAMMA) * RMADC
60 SUMC = RESID + SUMC
C = ABS(SI,C/RMADC)
IF(C.LE.STAR)ARLC = ARLC + 1
RETURN
END

```

```

FUNCTION SMOOT(RESID,ALPHA,GAMMA,ARLS,SSTAR,RMAD,FIX,S)
IF(S.GT.SSTAR)RETURN
IF(ARLS.GT.0) GOTO 50
S = 0
SUMS = 0
RMADS = RMAD
IF(FIX.EQ.1) GOTO 60
50 RMADS = GAMMA * ABS(RESID) + (1-GAMMA) * RMADS
60 SUMS = GAMMA * RESID + (1-GAMMA) * SUMS
S = ABS(SUMS/RMADS)
IF(S.LE.SSTAR)ARLS = ARLS + 1
RETURN
END

```

```

FUNCTION AUTO(RESID,ALPHA,GAMMA,ARLA,ASTAR,RMSE,FIX,A)
IF(A.GT.ASTAR)RETURN
IF(ARLA.GT.0) GOTO 50
RESID1 = 0
RMSEA = RMSE
COV = 0
IF(FIX.EQ.1) GOTO 60
50 RMSEA = RESID ** 2 + (1-GAMMA) * RMSEA
60 COV = RESID * RESID1 + (1-GAMMA) * COV
RESID1 = RESID
A = COV/RMSEA
IF(A.LE.ASTAR)ARLA = ARLA + 1
RETURN
END

```

```
SUBROUTINE CONTR(L,H,STAR,ZARL)
```

```
IF(ZARL.LT.99) GOTO 1000
```

```
IF(ZARL.GT.101)GOTO 900
```

```
RETURN
```

```
1000 L = STAR
```

```
STAR= (L + H)/2
```

```
RETURN
```

```
900 H = STAR
```

```
STAR= (L + H)/2
```

```
RETURN
```

```
END
```



```

C *-----*
C *           THIS PROGRAM TO COMPUTED AVERAGE           *
C *           RUN LENGTH OF TRACKIN SIGNAL TEST; CUSUM, SMOOTHED *
C *           ERROR, AUTOCORRELATION BACKWARD CUSUM      *
C *-----*
C *           DESCRIPTION SOME VARIABLE                   *
C *           ZA(I)   =  DEPENDENT VARIABLE               *
C *           I       =  INDEPENDENT VARIABLE            *
C *           E       =  ERROR                           *
C *-----*
          DIMENSION ZA(200), SDARLC(1000), SDARLS(1000), SDARLA(1000),
1          SCARLB(1000)
          REAL NORMAL, MEAN
          COMMON IX
          ALPHA      =  0.10
          GAMMA      =  0.05
          FIX        =  0
          WRITE(6,2)ALPHA
2          FORMAT(10X," ALPHA = ", F4.2, "//, 10X, " STEP SIZE ", 5X,
1          " AVERAGE RUN LENGTH ", 5X, " STANDARD ERROR ")
C          W          =  0.3
C          HL         =  25.0
C          HH         =  40.0
C          BSTAR      =  HL
C          CCL        =  10
C          CCH        =  20
C          CSTAR      =  39.79
C          CSL        =  0.1
C          CSH        =  0.5
C          SSTAR      =  39.79
C          CAL        =  0.1
C          CAH        =  0.7
C          ASTAR      =  0.48264

```

C *-----INITIAL VALUE-----*

```

ARLB = 0
ARLC = 0
ARLS = 0
ARLA = 0
MEAN = 0
SD = 1
B0 = 0
B1 = 1
B2 = 0
FLAGC = 0
FLAGS = 0
FLAGA = 0
FLAGB = 0
N = 20
DELTA = 0
SUMZ = 0
SUMBZ = 0
I0 = N
SARLC = 0
SARLS = 0
SARLA = 0
SARLB = 0
ZARL = 0
DO 10 I= 1,N
    E = NORMAL(MEAN,SD)
    IF(I.GT.I0) DELTA=1
    ZA(I) = B0 + B1 * I + E
    SUMZ = SUMZ + ZA(I)
    SUMBZ = SUMBZ + ((I - (N + 1)/2) * ZA(I))
10 CONTINUE
ZBAR = SUMZ/N
B1HAT = 12 * SUMBZ/(N ** 3 - N)
BOHAT = ZBAR - B1HAT * ((N + 1)/2)
S01 = BOHAT - ((1 - ALPHA)/ALPHA) * B1HAT
S02 = BOHAT - 2 * ((1 - ALPHA)/ALPHA) * B1HAT

```

```

C *-----CASE FIXED VARIANCE-----FIX = 1 -----*
C *-----CASE SMOOTHED VARIANCE-----FIX = 0 -----*

S1  = S11
S2  = S21
H   = HL
CC  = CCL
CS  = CSL
CA  = CAL
DO 550 J = 1,6
B2  = B2 + 0.5
ARL = 0
SARL = 0
M   = 20
SN  = 1000
IX  = 39567
DO 100 K = 1,1000
IF (K.EQ.M) IX = IX + 12.03567
IF (K.EQ.M.) M = M + 20
IN  = N + 1
NL  = 101 + N
CALL VAR(SD,C1,RMAD,RMSE,SIGMA,ALPHA)
DO 30 I = IN.NL
    E = NORMAL(MEAN, SD)
    IF(I.GT.I0) DELTA = 1
    Z = B0 + B1 * I + B2 * (I-I0) * DELTA + E
    ZHAT1 = ((2 + ALPHA/(1 - ALPHA) * S11) - ((1 + ALPHA/
1      (1 - ALPHA)) * S21)
RESID = Z - ZHAT1
S11 = ALPHA * Z + (1 - ALPHA) * S11
S21 = ALPHA * S11 + (1 - ALPHA) * S21
IF(FLAGC.EQ.0)ARLC = CUSUM(RESID.ALPHA.GAMMA.ARLC.CSTAR.
1      RMAD.FIX.C)
IF(FLAGS.EQ.0)ARLS = SMOOT(RESID.ALPHA.GAMMA.ARLS.SSTAR.
1      RMAD.FIX.S)
IF(FLAGA.EQ.0)ARLA = AUTO(RESID.ALPHA.GAMMA.ARLA.ASTAR.
1      RMSE.FIX.A)
IF(FLAGB.EQ.0.AND.FIX.EQ.1)ARLB = BACK(RESID.ALPHA.ARLB.

```


SIGMA . W . DP . DM . BSTAR)

1

30 CONTINUE

```

SARLC = SARLC + ARLC
SARLS = SARLS + ARLS
SARLA = SARLA + ARLA
IF(FIX.EQ.1) SARLB = SARLB + ARLB
SDARLC(K) = ARLC
SDARLS(K) = ARLS
SDARLA(K) = ARLA
IF(FIX.EQ.1) SDARLB(K) = ARLB
S11 = S1
S12 = S2
DP = 0
DM = 0
C = 0
S = 0
A = 0

```

100 CONTINUE

```

ZARLC = SARLC/1000
ZARLS = SARLS/1000
ZARLA = SARLA/1000
IF(FIX.EQ.1) ZARLB = SARLB/1000
DO 150 L = 1,1000
SSARLC = SSARLC + (SDARLC(L) - ZARLC) ** 2
SSARLS = SSARLS + (SDARLS(L) - ZARLS) ** 2
SSARLA = SSARLA + (SDARLA(L) - ZARLA) ** 2
IF(FIX.EQ.1) SSARLB + (SDARLB(L) - ZARLB) ** 2

```

150 CONTINUE

```

STDC = SQRT (SSARLC/999)
STDS = SQRT (SSARLS/999)
STDA = SQRT (SSARLA/999)
IF(FIX.EQ.1) STDB = SQRT (SSARLB/999)
SSARLC = 0
SSARLS = 0
SSARLA = 0
SSARLB = 0
SARLC = 0

```

```
SARLS = 0
SARLA = 0
SARLB = 0
550 CONTINUE
WRITE(6,200) B2, ZARLC, STDC
200 FORMAT(14X, F3.2, 16X, F6.2, 11X, F10.7)
WRITE(6,300) B2, ZARLS, STDS
300 FORMAT(14X, F3.2, 16X, F6.2, 11X, F10.7)
WRITE(6,400) B2, ZARLA, STDA
400 FORMAT(14X, F3.2, 16X, F6.2, 11X, F10.7)
IF(FIX.EQ.O) GOTO 490
WRITE(6,450) B2, ZARLB, STDB
450 FORMAT(14X, F3.2, 16X, F6.2, 11X, F10.7)
490 STOP
END
```

```

SUBROUTINE VAR(SD,C1,RMAD, RMSE, SIGMA, ALPHA)
  IF(ALPHA.EQ.0.1) GOTO 25
  IF(ALPHA.EQ.0.2) GOTO 15
  RMAD = SQRT(1.542 * SD * (2/3.14159))
  RMSE = SQRT(1.542) * SD
  SIGMA= 1.542 * SD
  RETURN
15  RMAD = SQRT(1.293 * SD * (2/3.14159))
  RMSE = SQRT(1.293) * SD
  SIGMA= 1.293 * SD
  RETURN
  RMAD = SQRT(1.135 * SD * (2/3.14159))
  RMSE = SQRT(1.293) * SD
  SIGMA= 1.135 * SD
  RETURN

FUNCTION BACK(RESID,ALPHA,ARLB, SIGMA,W,DP,DM,BSTAR)
  IF(DP.LT.0.OR.DM.GT.0) RETURN
  IF(ARLB.GT.0) GOTO 50
  RL0 = SIGMA * W * BSTAR
  DP = RL0
  RML0 = -1 * RL0
  DM = RML0
  ARLB = 0
50  IF(DP.LE.RL0.)DP = DP + (SIGMA * W) - RESID
  IF(DP.GT.RL0.)DP = RL0 + (SIGMA * W) - RESID
  IF(DM.LE.RML0)DM = RML0 -(SIGMA * W)-RESID
  IF(DM.GT.RML0)DM = DM - (SIGMA * W) - RESID
  IF(DP.GE.0AND.DM.LE.0)ARLB + 1
  RETURN
END

FUNTION CUSUM (RESID,ALPHA,GAMMA,ARLC,CSTAR,RMAD, FIX,C)
  IF(C.GT.CSTAR) RETURN
  IF(ARLC.GT.0) GOTO 50
  C = 0
  SUMC = 0

```



```

RMADC = RMAD
IF(FIX.EQ.1) GOTO 60
50 RMADC = GAMMA * ABS(RESID) + (1-GAMMA) * RMADC
60 SUMC = RESID + SUMC
C = ABS(SI,C/RMADC)
IF(C.LE.STAR)ARLC = ARLC + 1
RETURN
END

```

```

FUNCTION SMOOT(RESID,ALPHA,GAMMA,ARLS,SSTAR,RMAD,FIX,S)
IF(S.GT.SSTAR)RETURN
IF(ARLS.GT.0) GOTO 50
S = 0
SUMS = 0
RMADS = RMAD
IF(FIX.EQ.1) GOTO 60
50 RMADS = GAMMA * ABS(RESID) + (1-GAMMA) * RMADS
60 SUMS = GAMMA * RESID + (1-GAMMA) * SUMS
S = ABS(SUMS/RMADS)
IF(S.LE.SSTAR)ARLS = ARLS + 1
RETURN
END

```

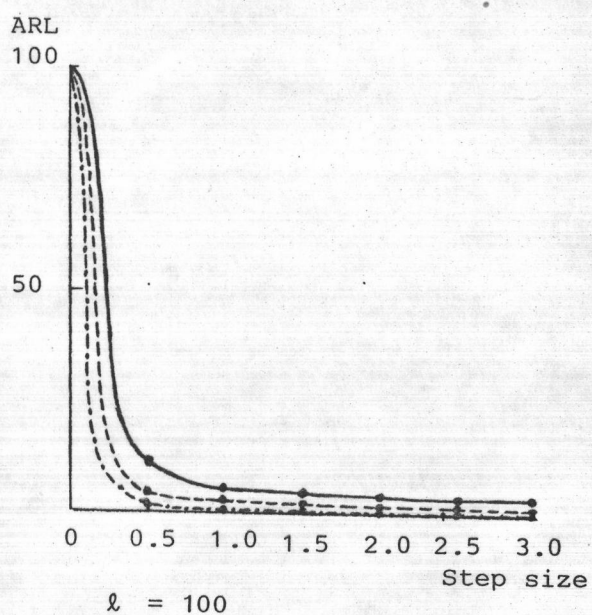
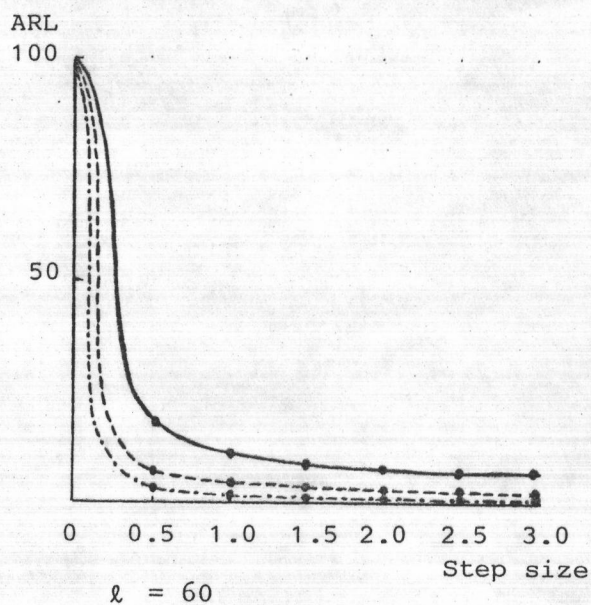
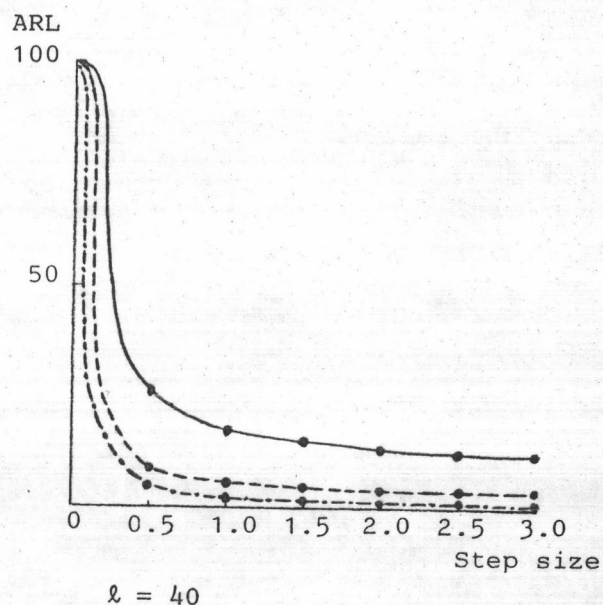
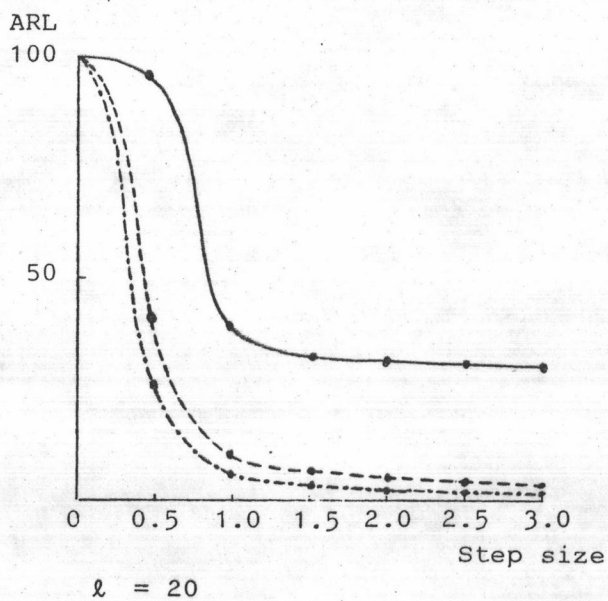
```

FUNCTION AUTO(RESID,ALPHA,GAMMA,ARLA,ASTAR,RMSE,FIX,A)
IF(A.GT.ASTAR)RETURN
IF(ARLA.GT.0) GOTO 50
RESID1 = 0
RMSEA = RMSE
COV = 0
IF(FIX.EQ.1) GOTO 60
50 RMSEA = RESID ** 2 + (1-GAMMA) * RMSEA
60 COV = RESID * RESID1 + (1-GAMMA) * COV
RESID1 = RESID
A = COV/RMSEA
IF(A.LE.ASTAR)ARLA = ARLA + 1
RETURN
END

```

รูปที่ ข.1 แสดงความสัมพันธ์ของค่า ARL และ Step size ของวิธีการตรวจสอบ 3 วิธี กรณีที่ค่าความแปรปรวน MAD และ MSE มีค่าไม่คงที่ เมื่อ ℓ มีค่าต่างๆ

$\alpha = 0.1 \quad \gamma = 0.05$

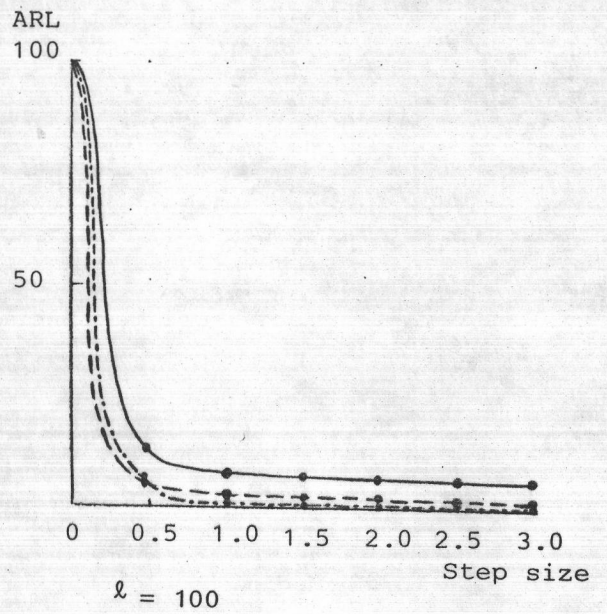
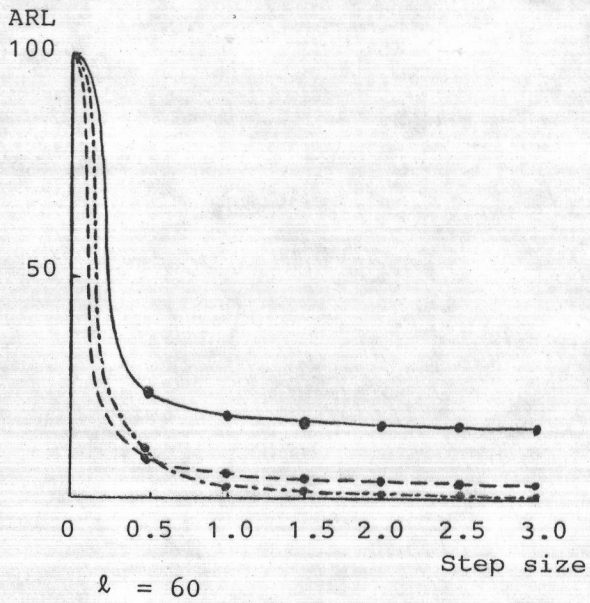
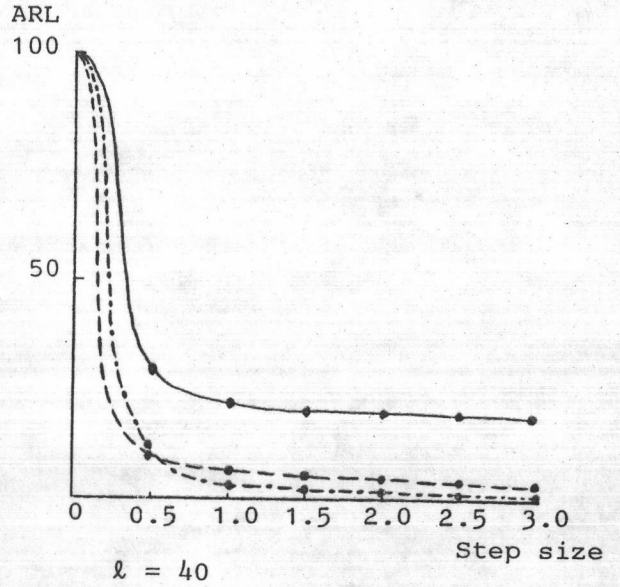
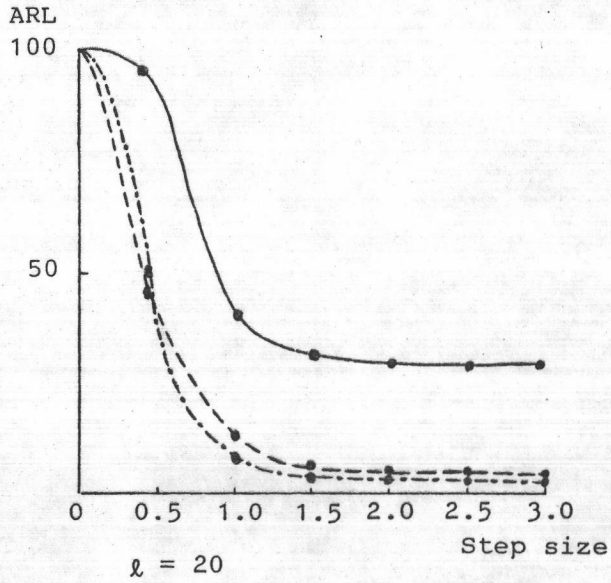


- CUSUM
- - - Smoothed error
- · - · - Autocorrelation

รูปที่ ข.1 (ต่อ)

$\alpha = 0.1$

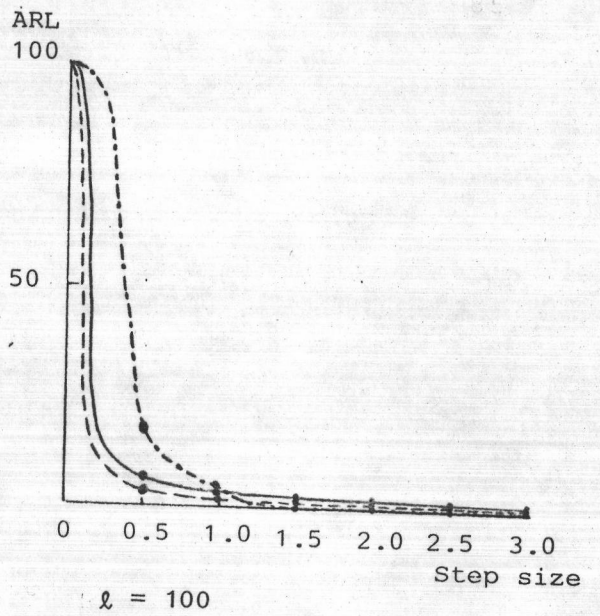
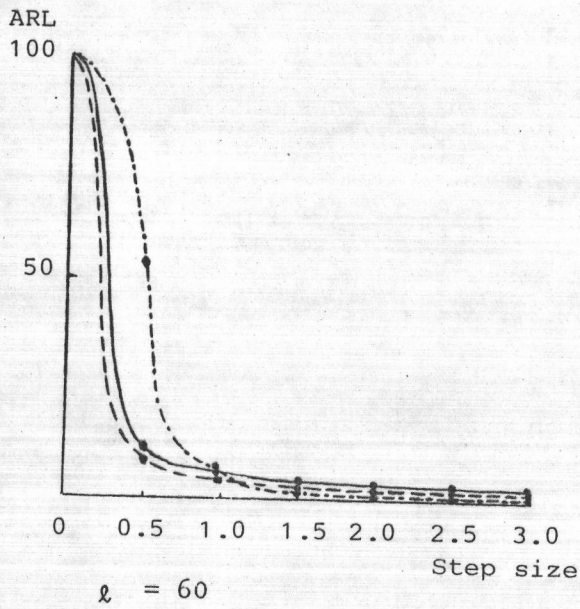
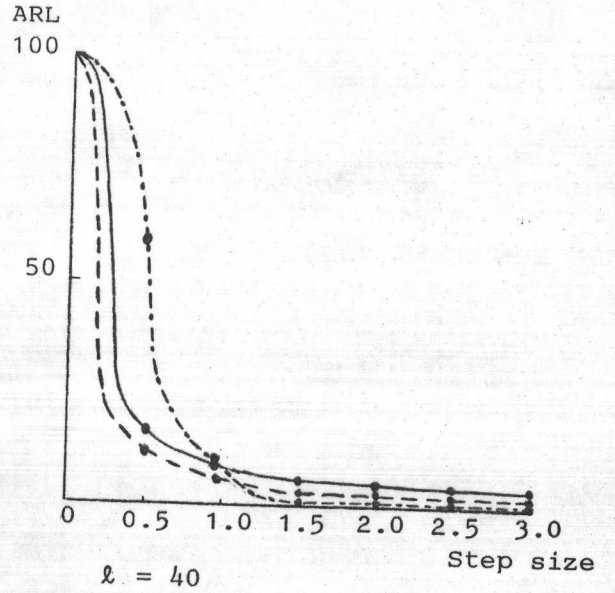
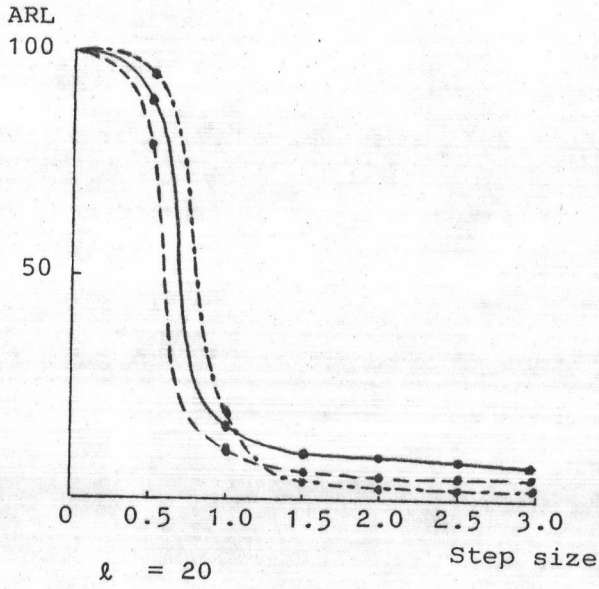
$\gamma = 0.1$



รูปที่ ข.1 (ต่อ)

$\alpha = 0.20$

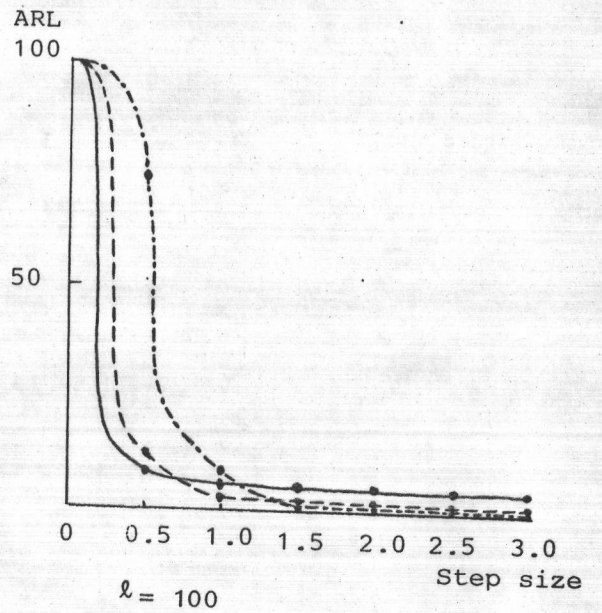
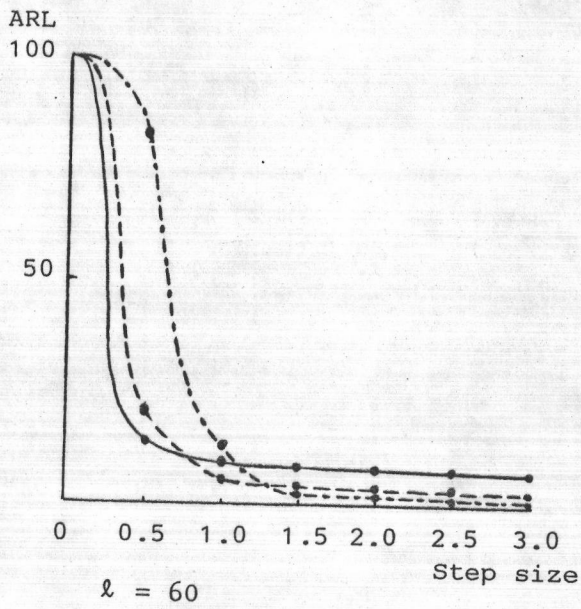
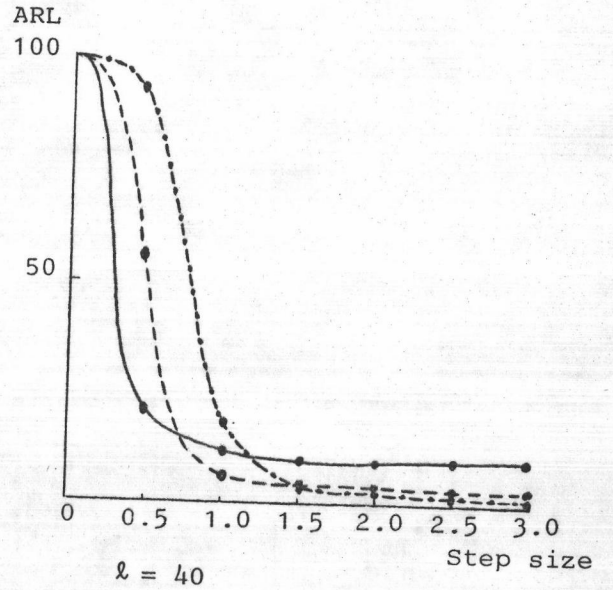
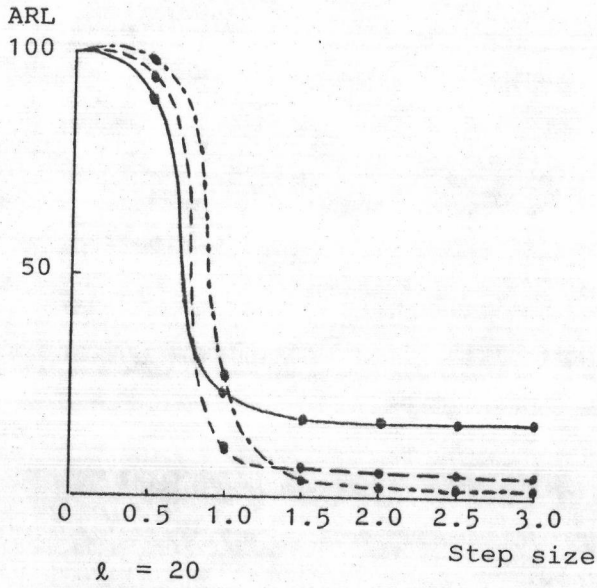
$\gamma = 0.05$



รูปที่ ๗.๑ (ต่อ)

$\alpha = 0.2$

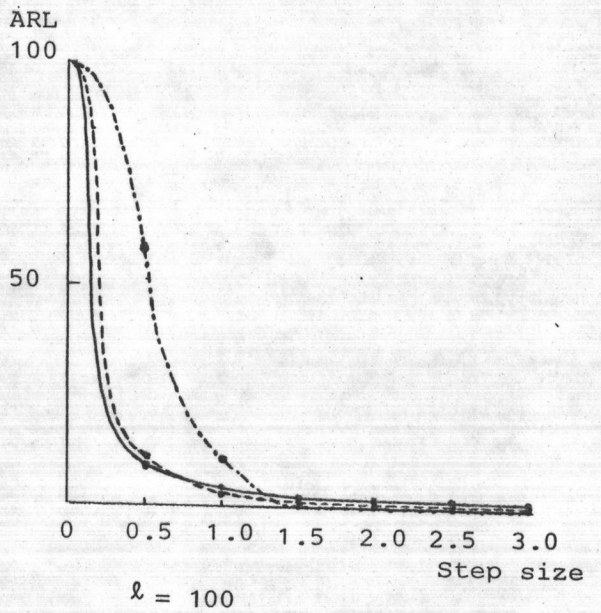
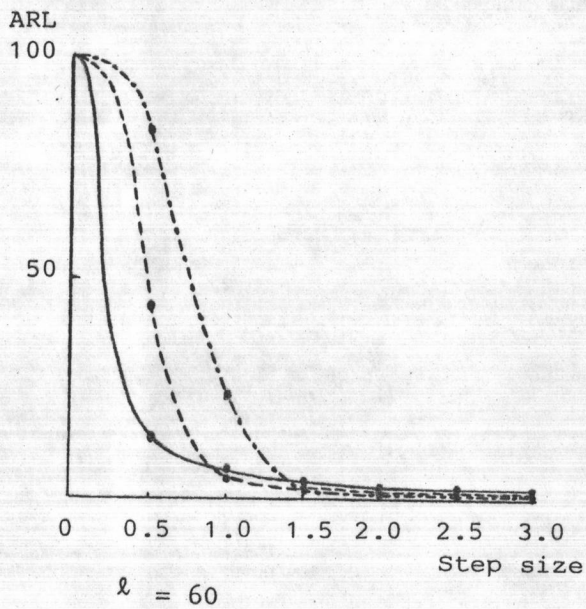
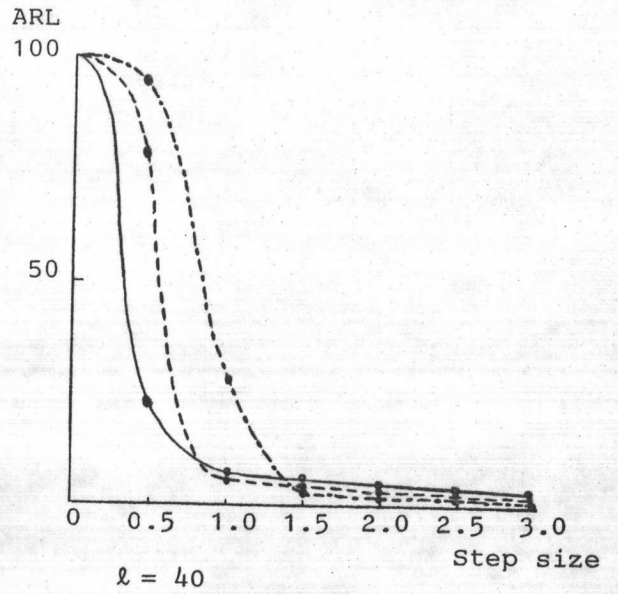
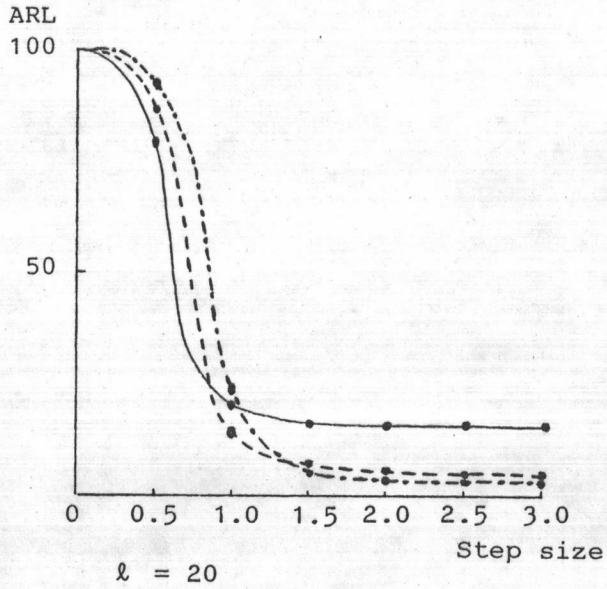
$\gamma = 0.2$



รูปที่ ข.1 (ต่อ)

$\alpha = 0.3$

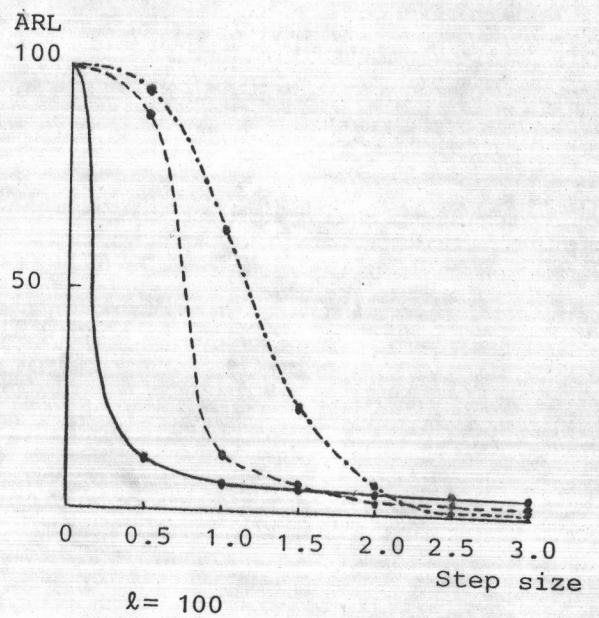
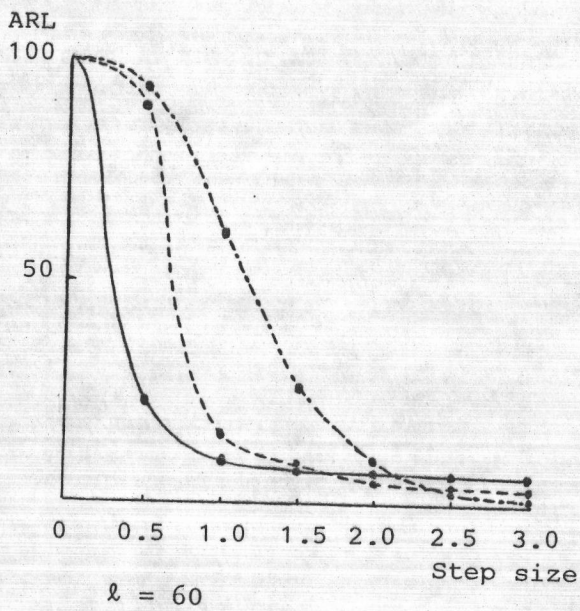
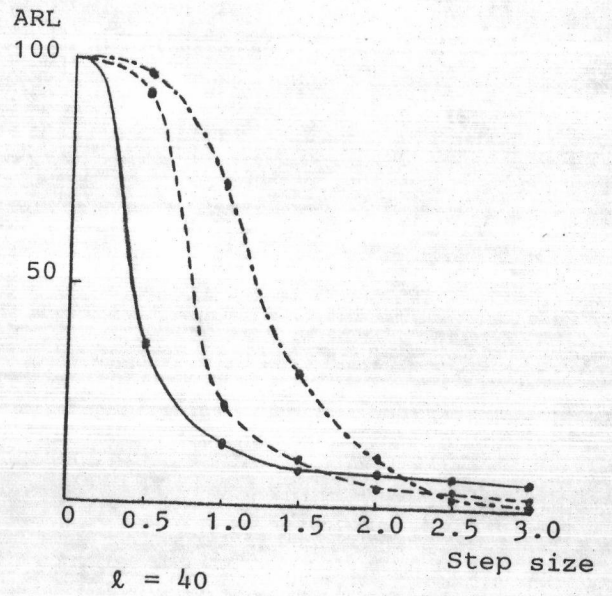
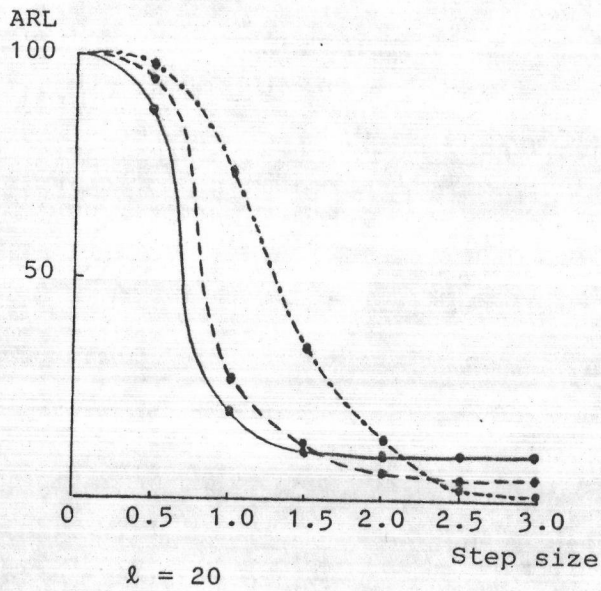
$\gamma = 0.05$



รูปที่ ข.1 (ต่อ)

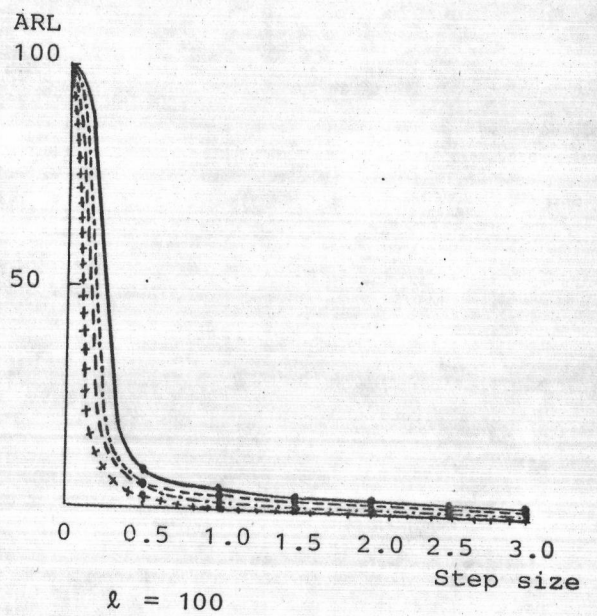
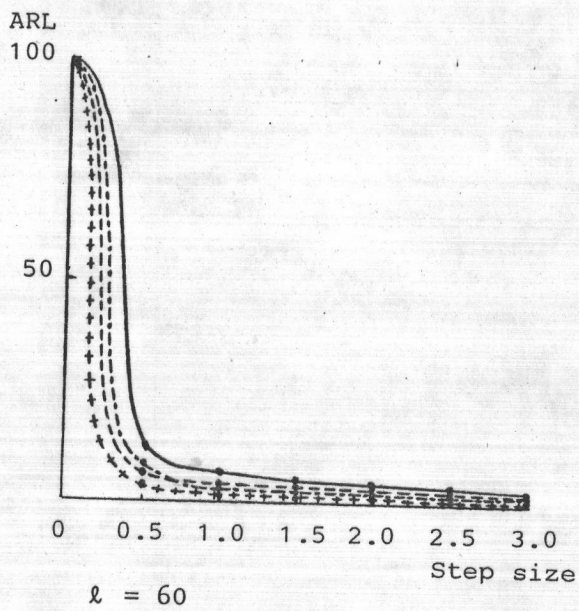
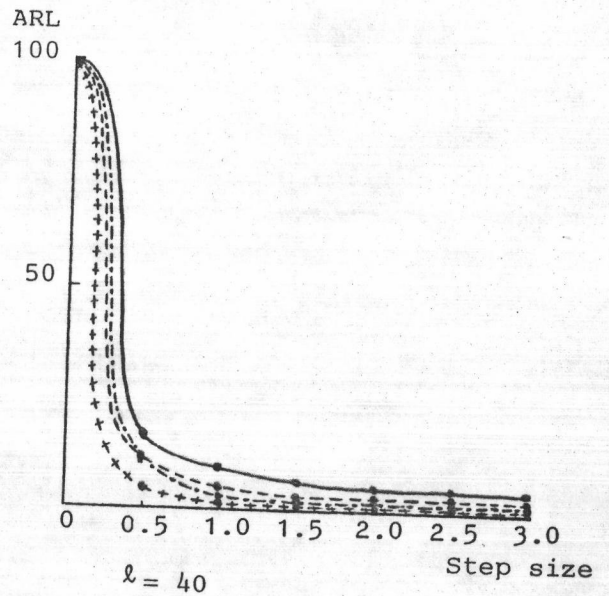
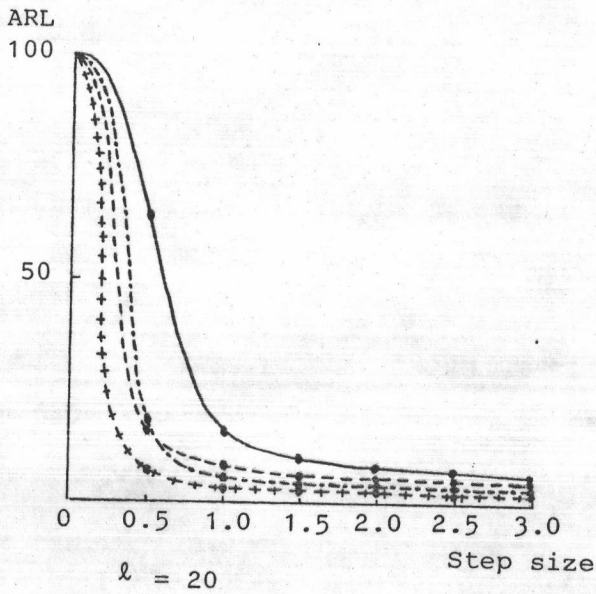
$\alpha = 0.3$

$\gamma = 0.3$



รูปที่ ข.2 แสดงความสัมพันธ์ของค่า ARL และ Step size ของวิธีการตรวจสอบ 4 วิธี กรณีที่ค่าความแปรปรวน MAD และ MSE มีค่าคงที่ เมื่อ ℓ มีค่าต่างๆ

$\alpha = 0.1$ $\gamma = 0.1$

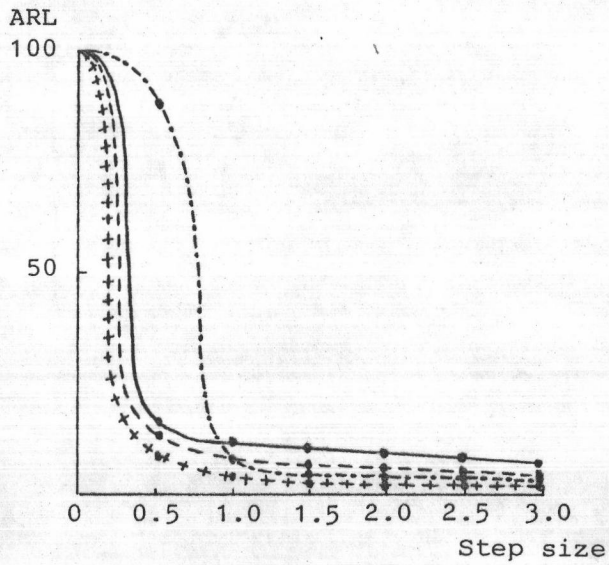


- CUSUM
- Smoothed error
- - - - Autocorrelation
- +++++++ Backward CUSUM

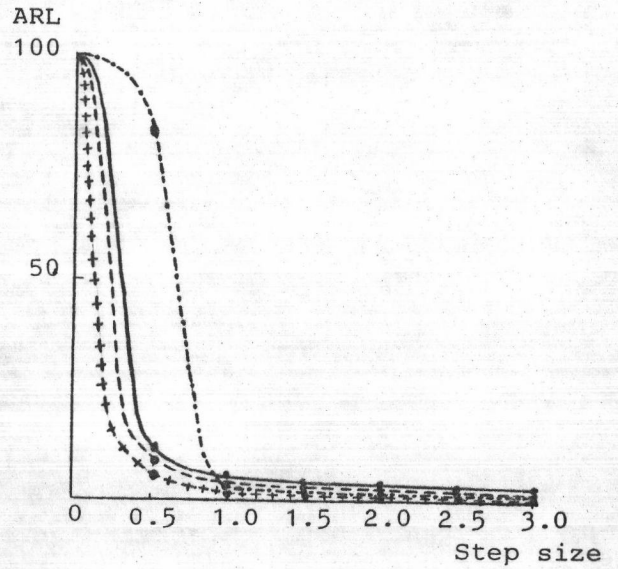
รูปที่ ข.2 (ต่อ)

$\alpha = 0.2$

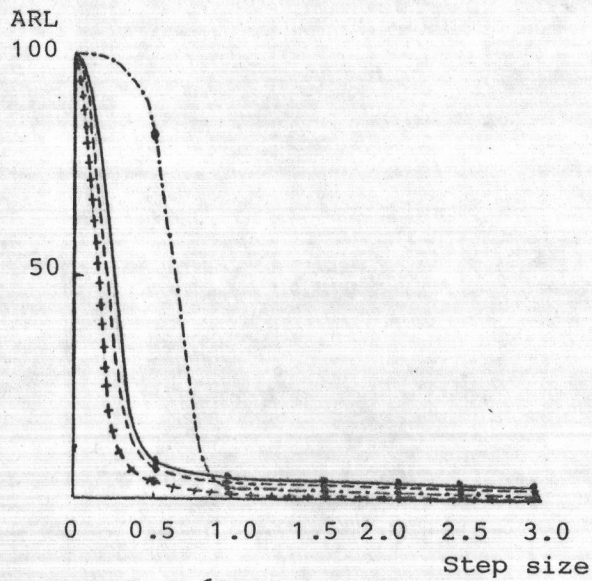
$\gamma = 0.2$



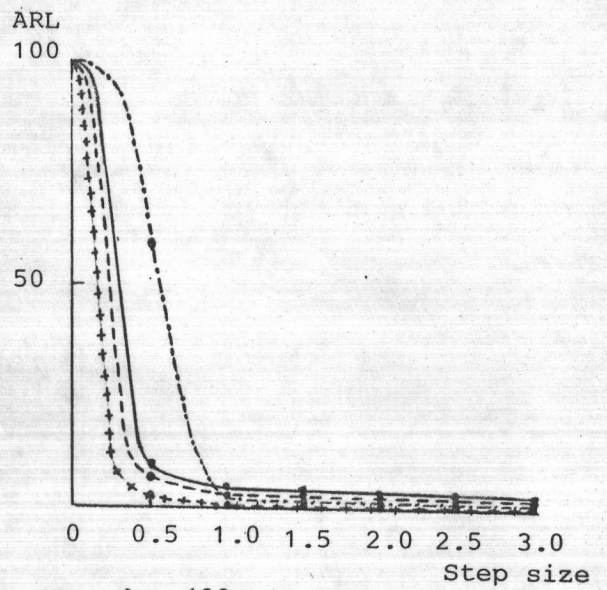
$l = 20$



$l = 40$



$l = 60$

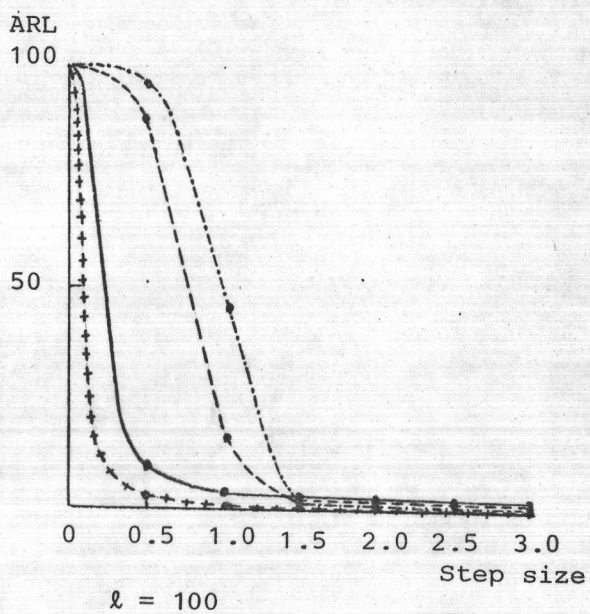
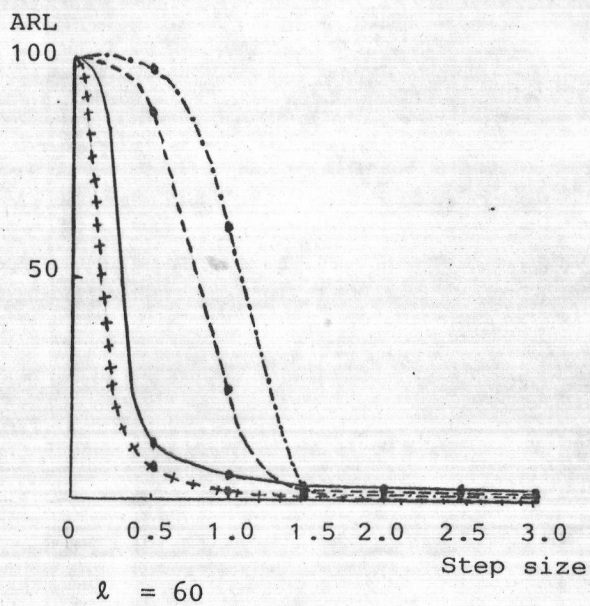
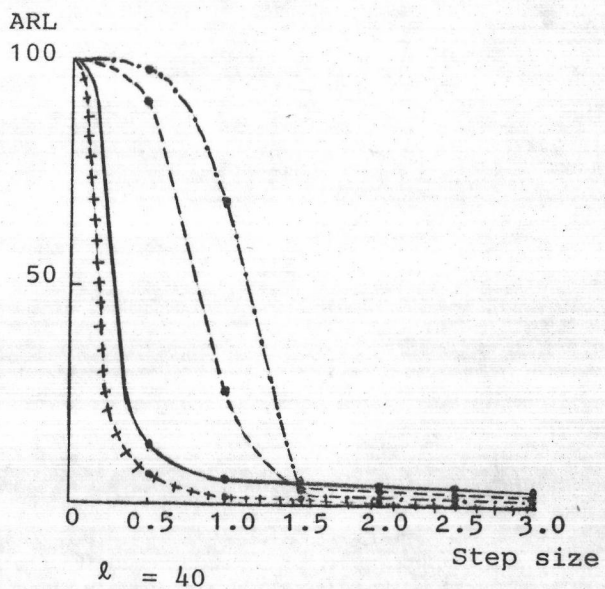
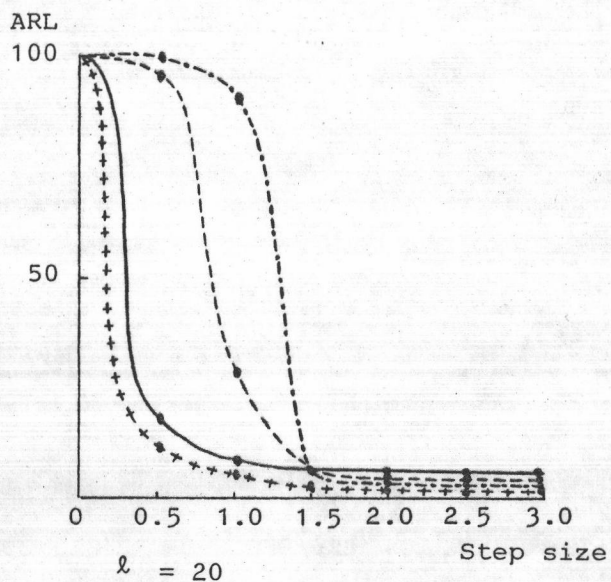


$l = 100$

ตารางที่ ข.2 (ต่อ)

$\alpha = 0.3$

$\gamma = 0.3$





ประวัติผู้เขียน

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เมื่อปีการศึกษา 2529 เข้าศึกษาในภาควิชาสถิติ คณะพาณิชยศาสตร์และการบัญชี จุฬาลงกรณ์
มหาวิทยาลัย เมื่อปีการศึกษา 2529

✓