Algorithm AS 261: Quantiles of The Distribution of The Square of The Sample Multiple-Correlation Coefficient
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Algorithm AS 261

Quantiles of the Distribution of the Square of the Sample Multiple-correlation Coefficient

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Keywords: Illinois method; Multiple-correlation coefficient; Secant method

Language

Fortran 77

Description and Purpose

Let $X_1, \ldots, X_p$ be distributed as $N_p(\mu, \Sigma)$ and R be the sample multiple-correlation coefficient between X_i and the other $p-1$ random variables based on a sample of size N. The cumulative distribution function (CDF) of R^2 is

$$M(R^2; p, N, \rho^2) = \int_0^{R^2} g(t)\,\mathrm{d}t, \qquad 0 \leqslant R^2 \leqslant 1, \tag{1}$$

where ρ denotes the population multiple-correlation coefficient and $g(R^2)$ is the density of R^2 (see Anderson (1984) for its expression). For given values of m $(0 \leqslant m \leqslant 1)$, $p\,(>1)$, $N\,(>p)$ and ρ^2 $(0 \leqslant \rho^2 \leqslant 1)$, the function subprogram SQMCQ returns the value of R^2 such that $M(R^2; p, N, \rho^2) = m$.

Numerical Method

Let $X = R^2$ and $f(x) = M(x; p, N, \rho^2) - m$. The equation $f(x) = 0$ is to be solved. f is a strictly increasing function and the solution is unique. A modification of the secant method, called the Illinois method (see Dowell and Jarratt (1971) and Kennedy and Gentle (1980)), is used to find the root.

Given two values x_i and x_{i-1}, the next approximation x_{i+1} to the root is determined by

$$x_{i+1} = x_i - \frac{f(x_i)(x_i - x_{i-1})}{\{f(x_i) - f(x_{i-1})\}}. \tag{2}$$

The end points unity and zero serve as two starting values x_0 and x_1. Iterations are performed according to the following rules.

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(a) If $f(x_{i+1})\, f(x_i) < 0$, then $(x_{i-1}, f(x_{i-1}))$ is replaced by $(x_i, f(x_i))$.
(b) If $f(x_{i+1})\, f(x_i) > 0$, then $(x_{i-1}, f(x_{i-1}))$ is replaced by $(x_{i-1}, f(x_{i-1})/2)$.

After these two rules have been applied, $(x_{i+1}, f(x_{i+1}))$ replaces $(x_i, f(x_i))$. The convergence criterion is based on $|x_{i+1} - x_i|$ and $|f(x_{i+1})|$ (relatively).

Structure

REAL FUNCTION SQMCQ(CDF, IP, N, RHO2, IFAULT)

Formal parameters

CDF	Real	input:	the cumulative probability m (at which the quantile is desired)
IP	Integer	input:	the number of random variables p
N	Integer	input:	the sample size N
RHO2	Real	input:	the square of the population multiple-correlation coefficient ρ^2
IFAULT	Integer	output:	a fault indicator: $=1$ if there is no convergence after n iterations in SQMCOR; $=2$ if $p<1$, $p>N$, $\rho^2<0$ or $\rho^2>1$; $=3$ if $m<0$ or $m>1$; $=0$ otherwise

Auxiliary Algorithms

The auxiliary routine SQMCOR (Ding and Bargmann, 1991) is invoked by function SQMCQ to evaluate the CDF of R^2. SQMCOR calls algorithm CACM 291 (Pike and Hill, 1966) and algorithm AS 63 (Majumder and Bhattacharjee, 1973).

Constants

The variable EPS in the DATA statement represents a small real number to indicate the convergence criterion. The value given here is 1.0×10^{-6}.

Precision

Double-precision operation may be performed by changing REAL to DOUBLE PRECISION in the REAL statement. The real constants in the DATA statements also need to be in double precision, and the value of EPS may be changed from 1.0×10^{-6} to 1.0×10^{-12} to increase the accuracy. The auxiliary routines must also be converted to double precision.

Time

No absolute timings are given here since the execution time depends entirely on the values of the input parameters.

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```
      REAL FUNCTION SQMCQ(CDF, IP, N, RHO2, IFAULT)
C
C        ALGORITHM AS 261  APPL. STATIST. (1991) VOL. 40, NO. 1
C
C        Returns the quantile of the distribution of the square
C        of the sample multiple correlation coefficient for
C        given values of CDF, IP, N, and RHO2
C
C        A modification of the secant method, called the
C        Illinois method, is used
C
C        The auxiliary algorithm SQMCOR, used to compute the
C        C.D.F. of the square of the sample multiple correlation
C        coefficient, is required
C
      INTEGER IP, N, IFAULT
      REAL CDF, RHO2
      REAL DIFF, EPS, F0, F1, F2, X0, X1, X2, ZERO, ONE, TWO
      REAL SQMCOR
      EXTERNAL SQMCOR
      DATA ZERO, ONE, TWO / 0.0, 1.0, 2.0 /
      DATA EPS / 1.0E-6 /
C
      SQMCQ = CDF
      IFAULT = 2
C
C        Perform domain check
C
      IF (RHO2 .LT. ZERO .OR. RHO2 .GT. ONE .OR. IP .LT. 2 .OR.
     *    N .LE. IP) RETURN
      IFAULT = 3
      IF (CDF .LT. ZERO .OR. CDF .GT. ONE) RETURN
      IFAULT = 0
      IF (CDF .EQ. ZERO .OR. CDF .EQ. ONE) RETURN
C
C        Use ONE and ZERO as two starting points for the
C        Illinois method
C
      X0 = ONE
      F0 = ONE - CDF
      X1 = ZERO
      F1 = -CDF
C
C        Continue iterations until convergence is achieved
C
   10 DIFF = F1 * (X1 - X0) / (F1 - F0)
      X2 = X1 - DIFF
      F2 = SQMCOR(X2, IP, N, RHO2, IFAULT) - CDF
      IF (IFAULT .NE. 0) RETURN
```

```
C
C       Check for convergence
C
      IF (ABS(F2) .LE. EPS * CDF) GO TO 20
      IF (ABS(DIFF) .LE. EPS * X2) GO TO 20
      IF (F2 * F1 .GE. ZERO) THEN
         F0 = F0 / TWO
      ELSE
         X0 = X1
         F0 = F1
      END IF
      X1 = X2
      F1 = F2
      GO TO 10
C
   20 SQMCQ = X2
      RETURN
      END
```

Algorithm AS 262

A Two-sample Test for Incomplete Multivariate Data

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Keywords: Censored data; Gehan test; Incomplete data; Log-rank test; Multivariate test

Language

Fortran 77

Description and Purpose

Wei and Lachin (1984) described a family of asymptotically distribution-free tests for equality of two multivariate distributions based on censored data. These tests are natural generalizations of the log-rank test (Mantel, 1966) and the generalized Wilcoxon test of Gehan (1965), both used extensively in the comparison of time-to-failure distributions between two groups. These methods properly take into account the possibly censored nature of events that contain only partial information about the random variables of interest. The generalized tests are obtained on the basis of the commonly used random censorship model (Kalbfleisch and Prentice, 1980), where the censoring vectors for each subject are mutually independent and also are independent of the underlying failure time vectors.

Censored multivariate time-to-event data are encountered frequently in clinical

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