# Package ‘dixonTest’

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**Type** Package  
**Title** Dixon's Ratio Test for Outlier Detection  
**Version** 1.0.3  
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**Description**  
For outlier detection in small and normally distributed samples the ratio test of Dixon (Q-test) can be used. Density, distribution function, quantile function and random generation for Dixon's ratio statistics are provided as wrapper functions. The core applies McBane's Fortran functions <doi:10.18637/jss.v016.i03> that use Gaussian quadrature for a numerical solution.

**License** GPL-3  
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**RoxygenNote** 7.1.1

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Dixon distribution

Description

Density, distribution function, quantile function and random generation for Dixon’s ratio statistics $r_{j,i-1}$ for outlier detection.

Usage

qdixon(p, n, i = 1, j = 1, log.p = FALSE, lower.tail = TRUE)
pdixon(q, n, i = 1, j = 1, lower.tail = TRUE, log.p = FALSE)
ddixon(x, n, i = 1, j = 1, log = FALSE)
rdixon(n, i = 1, j = 1)

Arguments

p vector of probabilities.
n number of observations. If length(n) > 1, the length is taken to be the number required
i number of observations <= x_i
j number of observations >= x_j
log.p logical; if TRUE (default), probabilities p are given as log(p)
lower.tail logical; if TRUE (default), probabilities are P[X <= x] otherwise, P[X > x].
q vector of quantiles
x vector of quantiles.
log logical; if TRUE (default), probabilities p are given as log(p).

Details

According to McBane (2006) the density of the statistics $r_{j,i-1}$ of Dixon can be yield if $x$ and $v$ are integrated over the range $(-\infty < x < \infty, 0 \leq v < \infty)$

$$f(r) = \frac{n!}{(i-1)!(n-j-i-1)!(j-1)!} \times \int_{-\infty}^{\infty} \int_{0}^{\infty} \left[ \int_{-\infty}^{x-v} \phi(t) dt \right]^{i-1} \left[ \int_{x-v}^{\infty} \phi(t) dt \right]^{n-j-i-1} \times \left[ \int_{x-rv}^{x-v} \phi(t) dt \right]^{j-1} \phi(x-v) \phi(x-rv) \phi(x)v \, dv \, dx$$

where $v$ is the Jacobian and $\phi(.)$ is the density of the standard normal distribution. McBane (2006) has proposed a numerical solution using Gaussian quadratures (Gauss-Hermite quadrature and half-range Hermite quadrature) and coded a library in Fortran. These R functions are wrapper functions to use the respective Fortran code.
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Value

ddixon gives the density function, pdixon gives the distribution function, qdixon gives the quantile function and rdixon generates random deviates.

Source

The R code is a wrapper to the Fortran code released under GPL >=2 in the electronic supplement of McBane (2006). The original files are 'rfuncs.f', 'utility.f' and 'dixonr.fi'. They were slightly modified to comply with current CRAN policy and the R manual ‘Writing R Extensions’.

Note

The file 'slowTest/d-p-q-r-tests.R.out.save' that is included in this package contains some results for the assessment of the numerical accuracy.

The slight numerical differences between McBane’s original Fortran output (see files 'slowTests/test[1,2,4].ref.output.txt') and this implementation are related to different floating point rounding algorithms between R (see ‘round to even’ in round) and Fortran’s write(*, ’F6.3’) statement.

References


Examples

```r
set.seed(123)
n <- 20
Rdixon <- rdixon(n, i = 3, j = 2)
Rdixon
pdixon(Rdixon, n = n, i = 3, j = 2)
ddixon(Rdixon, n = n, i = 3, j = 2)
```

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dixonTest

**Dixons Outlier Test (Q-Test)**

**Description**

Performs Dixons single outlier test.

**Usage**

dixonTest(x, alternative = c("two.sided", "greater", "less"), refined = FALSE)
Arguments

- **x**: a numeric vector of data
- **alternative**: the alternative hypothesis. Defaults to "two.sided"
- **refined**: logical indicator, whether the refined version or the Q-test shall be performed. Defaults to FALSE

Details

Let $X$ denote an identically and independently distributed normal variate. Further, let the increasingly ordered realizations denote $x_1 \leq x_2 \leq \ldots \leq x_n$. Dixon (1950) proposed the following ratio statistic to detect an outlier (two sided):

$$r_{j,i-1} = \max \left\{ \frac{x_n - x_{n-j}}{x_n - x_i}, \frac{x_{1+j} - x_1}{x_{n-i} - x_1} \right\}$$

The null hypothesis, no outlier, is tested against the alternative, at least one observation is an outlier (two sided). The subscript $j$ on the $r$ symbol indicates the number of outliers that are suspected at the upper end of the data set, and the subscript $i$ indicates the number of outliers suspected at the lower end. For $r_{10}$ it is also common to use the statistic $Q$.

The statistic for a single maximum outlier is:

$$r_{j,i-1} = \frac{(x_n - x_{n-j})}{(x_n - x_i)}$$

The null hypothesis is tested against the alternative, the maximum observation is an outlier.

For testing a single minimum outlier, the test statistic is:

$$r_{j,i-1} = \frac{(x_{1+j} - x_1)}{(x_{n-i} - x_1)}$$

The null hypothesis is tested against the alternative, the minimum observation is an outlier.

Apart from the earlier Dixons Q-test (i.e. $r_{10}$), a refined version that was later proposed by Dixon can be performed with this function, where the statistic $r_{j,i-1}$ depends on the sample size as follows:

- $r_{10}$: $3 \leq n \leq 7$
- $r_{11}$: $8 \leq n \leq 10$
- $r_{21}$: $11 \leq n \leq 13$
- $r_{22}$: $14 \leq n \leq 30$

The p-value is computed with the function `pdixon`.

References


**Examples**

```r
x <- c(40.02, 40.12, 40.16, 40.18, 40.18, 40.20)
dixonTest(x, alternative = "two.sided")

## example from the dataplot manual of NIST
x <- c(568, 570, 570, 570, 572, 578, 584, 596)
dixonTest(x, alternative = "greater", refined = TRUE)
```
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