Package ‘NOTAMO’

July 27, 2016

Type Package

Title NORmal To Anything with prespecified MOments

Version 0.8

Date 2016-07-27

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Description Estimates parameters of a quantile mixture cumulative distribution function to comply with prespecified central moments. The quantile mixture can be used with the NORTA algorithm to generate multivariate non-normally distruted samples with given covariance matrix and central moments.

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LazyData TRUE

Depends moments, rootSolve, nloptr, NORTARA

R topics documented:

`NOTAMO-package` *NORmal To Anything with prespecified MOments*

Description

Estimates parameters of a quantile mixture cumulative distribution function to comply with prespecified central moments. The quantile mixture can be used with the NORTA algorithm to generate multivariate non-normally distruted samples with given covariance matrix and central moments.

Details

NOTAMO estimates inverse cumulative distribution functions (CDFs) that comply with prespecified standardized moments and are a quantile mixture of prespecified inverse CDFs. This allows to generate samples from different distributions that all have the same e.g. skewness and kurtosis. The resulting inverse CDFs can be used in conjunction with the NORTA algorithm to generate multivariate samples with prespecified skewness, kurtosis, and covariance matrix.

Author(s)

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See Also

`NORTA_function`

`calc_std_mom` *Calculate standardized central moments*

Description

Calculates standardized sample central moments.

Usage

```
calc_std_mom(data, moment)
```

Arguments

`data`	A vector containing the univariate data
`moment`	An integer, order of moment to be calculated

Details

Calculates the sample central moment. If the order is 3, the output is the sample skewness, if the order is 4, the sample kurtosis, and otherwise the standardized central moment.

Author(s)

Max Auerswald and Morten Moshagen

See Also

`moment`

Examples

```
calc_std_mom(rnorm(1000),4)
```

gen_univar_NORTA *Generate univariate sample*

Description

Generates a sample from a distribution with prespecified moments.

Usage

```
gen_univar_NORTA(NORTA_fun_out, N)
```

Arguments

NORTA_fun_out	output of NORTA_function
N	sample size

Author(s)

Max Auerswald and Morten Moshagen

See Also

NORTA_function

NORTA_function *Estimate NORTA function*

Description

Estimates parameters of a quantile mixture distribution given a set of inverse cumulative distribution functions (CDFs) and prespecified central moments. The output is the inverse CDF of a distribution with the prespecified moments and can be used in conjunction with the NORTA algorithm.

Usage

```
NORTA_function(function_list, moments, acc = 6, startval = NULL,
               alg = "NLOPT_GN_CRS2_LM", maxeval = 500)
```

Arguments

function_list	A list of lists that contain inverse CDFs and optional parameters. The weighted sum of these inverse CDFs is used to find one CDF that complies with the prespecified moments. See Details and Examples for additional information.
moments	A matrix that contains the order and value of desired moments. The first column contains the order, the second column contains the value.
acc	An integer used to set up a vector of p-values to approximate the resulting distributions.
startval	Starting values for the weights in the quantile mixture distribution.

alg	Algorithm used in the non-linear optimization procedure. Default is a controlled random search with local mutation. See package nloptr for details.
maxeval	Maximum number of iterations used in the root solving or non-linear optimization procedure.

Details

The function estimates parameters a of a quantile mixture distribution of the form

$$a_1 F_1^{-1} + a_2 F_2^{-1} + ... + a_n F_n^{-1}$$

where F^{-1} denotes inverse cumulative distribution functions and $sum(a) = 1$. The result is the solution for the parameters a that are associated with a distribution having the desired central moments.

The function_list input is a list of lists. Every list contains one function that is an inverse CDF and optional additional parameters that are passed on to the respective inverse CDF (see Example 2). For most cases, it is recommended to use an inverse standard normal distribution as the final inverse CDF.

The function uses a non-linear root-finding algorithm if the number of prespecified moments is equal to the number of provided inverse CDFs plus one (see multiroot). If the number of prespecified moments is smaller than that, a non-linear optimization algorithm is used instead (see nloptr). In general, the non-linear root finding is faster and more accurate, but less flexible.

Value

solution	Parameters to be used for the quantile mixture distribution that yield a distribution with the desired central moments.
exp_moms	The moments expected when generating data from the resulting quantile mixture distribution.
ssd	The sum of the squared difference between desired and expected moments.
presp_moms	Prespecified moments (for comparison to expected moments).
presp_funs	Prespecified inverse CDFs

Note

The algorithm is not guaranteed to converge.

Author(s)

Max Auerswald and Morten Moshagen

See Also

nloptr,multiroot, gen_univar_NORTA

Examples

```
### Example 1: Root-finding algorithm (number of CDFs = number of prespecified moments + 1):

# Define set of three inverse CDFs:
icdf_list <- list(
  list(qexp),
  list(qnormcube <- function(p) {
    return(qnorm(p)^3)
  }),
  list(qnorm)
)

# Define target moments:
moms <- matrix(0,nrow=2,ncol=2)
moms[1,] <- c(3,1)   #desired skewness is 1
moms[2,] <- c(4,10)  #desired kurtosis is 10

# Estimate parameters:
res1 <- NORTA_function(icdf_list,moms)

# Generate univariate sample from distribution with given moments and N=1000:
y <- gen_univar_NORTA(res1,1000)

# Calculate kurtosis of random variable
calc_std_mom(y,4)

### Example 2: Non-linear optimization (number of CDFs > number of prespecified moments + 1):

# Define set of four inverse CDFs:
icdf_list2 <- list(
  list(qexp),
  list(qnormcube <- function(p) {
    return(qnorm(p)^3)
  }),
  list(qexp,rate=2),
  list(qnorm)
)

# Estimate parameters:
res2 <- NORTA_function(icdf_list2,moms)

# Generate univariate sample from distribution with given moments and N=100:
gen_univar_NORTA(res2,100)

# The resulting distribution is different from the first example, despite having the same
# skewness and kurtosis.


### Example 3: Multivariate distribution

# Define correlation matrix:
target_cor <- matrix(0,nrow=2,ncol=2)
target_cor[1,] <- c(1,0.4)
target_cor[2,] <- c(0.4,1)

# Define functions for NORTARA:
f1 <- function(x) {
  return(prep_NORTA(res1,x))
}
f2 <- function(x) {
  return(prep_NORTA(res2,x))
}
```

```
# Generate bivariate distribution with prespecified correlation matrix, skewness, kurtosis,
# and N=100:
genNORTARA(100,target_cor,invcdfnames = c('f1','f2'),defaultindex=c(1,2))
```

prep_NORTA *Prepare NORTA function*

Description

Converts the output of NORTA_function to be used as an inverse cumulative distribution function for the NORTA algorithm.

Usage

```
prep_NORTA(NORTA_fun_out,x)
```

Arguments

NORTA_fun_out	output of NORTA_function
x	vector of probabilities

Details

See Example 3 in NORTA_function.

Author(s)

Max Auerswald and Morten Moshagen

See Also

NORTA_function

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