Package 'ExactVaRTest'

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Title Exact Finite-Sample Value-at-Risk Back-Testing

Version 0.1.3

Language en-US

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Description Provides fast dynamic-programming algorithms in 'C++'/'Rcpp' (with pure 'R' fallbacks) for the exact finite-sample distributions and p-values of Christoffersen (1998) independence (IND) and conditional-coverage (CC) VaR backtests. For completeness, it also provides the exact unconditional-coverage (UC) test following Kupiec (1995) via a closed-form binomial enumeration. See Christoffersen (1998) <doi:10.2307/2527341> and Kupiec (1995) <doi:10.3905/jod.1995.407942>.

License GPL (>= 3)

Depends R (>= 3.5.0)

Imports Rcpp, stats

LinkingTo Rcpp

Suggests bench, dplyr, tidyr, purrr, ggplot2, xts, quantmod, knitr, rmarkdown, testthat (>= 3.0.0)

Encoding UTF-8

RoxygenNote 7.3.2

URL https://github.com/YujianCHEN219/ExactVaRTest

BugReports https://github.com/YujianCHEN219/ExactVaRTest/issues

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Repository CRAN

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Contents

`ExactVaRTest-package` *ExactVaRTest – Exact Finite-Sample VaR Back-Testing*

Description

Provides fast dynamic-programming algorithms (C++/Rcpp) – with pure-R fall-backs – for the exact finite-sample distributions and p-values of Christoffersen's (1998) VaR back-tests: Independence (IND) and Conditional Coverage (CC) tests, and the Unconditional Coverage (UC) test via closed-form binomial enumeration.

Author(s)

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See Also

Useful links:

- https://github.com/YujianCHEN219/ExactVaRTest
- Report bugs at https://github.com/YujianCHEN219/ExactVaRTest/issues

backtest_all *Exact UC/IND/CC back-tests in one call*

Description

Exact UC/IND/CC back-tests in one call

Usage

```
backtest_all(x, alpha = 0.05, sig = 0.05, prune_threshold = 1e-15)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.
sig	Significance level (default 0.05).
prune_threshold	Passed to the dynamic programming engine.

Value

An object of class "ExactVaRBacktestAll" (a named list) with components: uc, ind, cc (each a list with stat, pval, reject), and scalars sig (significance level), alpha (model exception probability), n (sample size).

Examples

```
set.seed(1)
x <- rbinom(300, 1, 0.02)
backtest_all(x, alpha = 0.02)
```

backtest_lr *Exact finite-sample back-test for a VaR exception series*

Description

Exact finite-sample back-test for a VaR exception series

Usage

```
backtest_lr(
  x,
  alpha = 0.05,
  type = c("uc", "ind", "cc"),
  sig = 0.05,
  prune_threshold = 1e-15
)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.
type	"uc", "ind" or "cc".
sig	Significance level (default 0.05).
prune_threshold	Passed to the dynamic-programming engine.

Value

An object of class "ExactVaRBacktest" (a named list) with components: stat (numeric LR statistic), pval (numeric exact p-value in $[0, 1]$), reject (logical; TRUE if p < sig), type (character; one of "uc", "ind", "cc"), alpha (numeric model exception probability), sig (numeric significance level), n (integer sample size).

Examples

```
set.seed(123)
x <- rbinom(250, 1, 0.01)
backtest_lr(x, alpha = 0.01, type = "uc")
```

---

lr_cc_dist *Exact LR_cc (and LR_uc) distribution (auto-select engine)*

Description

Returns the finite-sample distribution of Christoffersen's conditional-coverage statistic LR_{cc}. The returned list also includes the matching unconditional-coverage distribution LR_{uc}, produced by the same dynamic-programming run.

Usage

```
lr_cc_dist(n, alpha = 0.05, prune_threshold = 1e-15)
```

Arguments

n	Integer sample size ($n \geq 1$).
alpha	Exception probability $\alpha \in (0, 1)$.
prune_threshold	Probability below which states are pruned by the dynamic-programming recursion.

Value

A named list with elements LR_cc, prob_cc, LR_uc, prob_uc. The pairs (LR_cc, prob_cc) and (LR_uc, prob_uc) have equal lengths; each probability vector is in $[0, 1]$ and sums to 1.

Examples

```
lr_cc_dist(8, 0.05)
```

---

lr_cc_stat *Christoffersen LR_cc statistic*

Description

Christoffersen LR_cc statistic

Usage

```
lr_cc_stat(x, alpha = 0.05)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.

Value

Numeric LR_cc statistic.

---

lr_ind_dist *Exact LR_ind distribution (auto-select engine)*

Description

Returns the finite-sample distribution of Christoffersen's independence statistic LR_{ind}.

Usage

```
lr_ind_dist(n, alpha = 0.05, prune_threshold = 1e-15)
```

Arguments

n	Integer sample size ($n \geq 1$).
alpha	Exception probability $\alpha \in (0, 1)$.
prune_threshold	Probability below which states are pruned by the dynamic-programming recursion.

Value

A named list with elements LR and prob of equal length, where LR is the support of the LR statistic and prob are the corresponding probabilities in $[0, 1]$ that sum to 1.

Examples

```
lr_ind_dist(8, 0.05)
```

---

lr_ind_stat *Christoffersen LR_ind statistic*

Description

Christoffersen LR_ind statistic

Usage

```
lr_ind_stat(x, alpha = 0.05)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.

Value

Numeric LR_ind statistic.

---

lr_uc_dist *Exact LR_uc distribution (closed-form binomial)*

Description

Exact LR_uc distribution (closed-form binomial)

Usage

```
lr_uc_dist(n, alpha = 0.05)
```

Arguments

n	Integer sample size ($n \geq 1$).
alpha	Exception probability $\alpha \in (0, 1)$.

Value

A named list with elements LR and prob of equal length, where LR is the support of the LR statistic and prob are the corresponding probabilities in $[0, 1]$ that sum to 1.

Examples

```
lr_uc_dist(8, 0.01)
```

lr_uc_stat *Christoffersen LR_uc statistic*

Description

Christoffersen LR_uc statistic

Usage

```
lr_uc_stat(x, alpha = 0.05)
```

Arguments

x	0/1 exception series.
alpha	Exception probability.

Value

Numeric LR_uc statistic.

print.ExactVaRBacktest *Print method for ExactVaRBacktest*

Description

Print method for ExactVaRBacktest

Usage

```
## S3 method for class 'ExactVaRBacktest'
print(x, digits = max(3L, getOption("digits") - 3L), ...)
```

Arguments

x	An object of class 'ExactVaRBacktest'.
digits	Number of digits to print.
...	Further arguments passed to or from other methods (ignored).

Details

Prints the test name, sample size n, model alpha, significance level, LR statistic, exact p-value, and the decision at the specified level.

Value

The input object x, returned invisibly (class ExactVaRBacktest).

print.ExactVaRBacktestAll *Print method for ExactVaRBacktestAll*

Description

Print method for ExactVaRBacktestAll

Usage

```
## S3 method for class 'ExactVaRBacktestAll'
print(x, digits = max(3L, getOption("digits") - 3L), ...)
```

Arguments

x	An object of class 'ExactVaRBacktestAll'.
digits	Number of digits to print.
...	Further arguments passed to or from other methods (ignored).

Details

Prints a header with sample size n, model alpha and significance level, followed by per-test blocks for UC, IND, and CC: LR statistic, exact p-value, and the decision at the specified level.

Value

The input object x, returned invisibly (class ExactVaRBacktestAll).

pval_lr_cc *Exact p-value for LR_cc*

Description

Exact p-value for LR_cc

Usage

```
pval_lr_cc(lr_obs, n, alpha = 0.05, prune_threshold = 1e-15)
```

Arguments

lr_obs	Observed LR_cc statistic.
n	Sample size.
alpha	Exception probability.
prune_threshold	State-pruning threshold for DP engine.

Value

Numeric exact p-value in $[0, 1]$; may be `NA_real_` if the finite-sample distribution is unavailable.

`pval_lr_ind` *Exact p-value for LR_ind*

Description

Exact p-value for LR_ind

Usage

```
pval_lr_ind(lr_obs, n, alpha = 0.05, prune_threshold = 1e-15)
```

Arguments

`lr_obs`	Observed LR_ind statistic.
`n`	Sample size.
`alpha`	Exception probability.
`prune_threshold`	State-pruning threshold for DP engine.

Value

Numeric exact p-value in $[0, 1]$; may be `NA_real_` if the finite-sample distribution is unavailable.

`pval_lr_uc` *Exact p-value for LR_uc*

Description

Exact p-value for LR_uc

Usage

```
pval_lr_uc(lr_obs, n, alpha = 0.05)
```

Arguments

`lr_obs`	Observed LR_uc statistic.
`n`	Sample size.
`alpha`	Exception probability.

Value

Numeric exact p-value in $[0, 1]$; may be `NA_real_` if the finite-sample distribution is unavailable.

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