

Package: KRONX (via r-universe)

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Type Package

Title Clock of Regimes for Regime-Switching Fragility Analysis

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Description Implements the Clock of Regimes (KRONX) framework for regime-switching fragility analysis of financial time series. The package fits Gaussian and Student-t Hidden Markov Models (HMMs) to return data, constructs a hazard-adjusted transition operator Q , derives the associated generator $K = Q - I$, and computes the fundamental matrix $N = -K$ inverse to characterize expected residence times under structural fragility.

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Encoding UTF-8

Depends R ($\geq 4.0.0$)

Imports stats, utils

Suggests testthat ($\geq 3.0.0$), knitr, rmarkdown

VignetteBuilder utils

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compute_log_returns	<i>Compute log returns from a close-price vector.</i>
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Description

Compute log returns from a close-price vector.

Usage

```
compute_log_returns(close)
```

Arguments

close Numeric vector of close prices.

Value

Numeric vector of log returns (length = length(close) - 1).

fit_hmm_em	<i>Fit a Gaussian or Student-t HMM via EM with multiple random restarts.</i>
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Description

Fit a Gaussian or Student-t HMM via EM with multiple random restarts.

Usage

```
fit_hmm_em(
  x,
  K = 3L,
  model = c("gaussian", "student"),
  n_starts = 5L,
  max_iter = 200L,
  tol = 1e-06,
  nu_grid = c(3:30, 40, 60, 100),
  verbose = TRUE
)
```

Arguments

<code>x</code>	Numeric vector of observations (log returns).
<code>K</code>	Integer number of hidden states.
<code>model</code>	"gaussian" or "student".
<code>n_starts</code>	Number of random restarts.
<code>max_iter</code>	Maximum EM iterations per restart.
<code>tol</code>	Log-likelihood convergence tolerance.
<code>nu_grid</code>	Candidate degrees-of-freedom for Student-t grid search.
<code>verbose</code>	Logical; if TRUE print iteration progress.

Value

A list with components:

- model** Model type string.
- A** $K \times K$ transition matrix.
- delta** Length- K initial state probability vector.
- params** List with μ , σ , and (Student-t) ν .
- gamma** $T \times K$ posterior state probabilities.
- xi** $(T-1) \times K \times K$ posterior joint transition probabilities.
- logLik** Scalar log-likelihood at convergence.
- n** Number of observations.
- K** Number of states.

<code>read_close_series</code>	<i>Read a close-price series from a CSV file.</i>
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Description

The function is case-insensitive: it accepts `close`, `Close`, `CLOSE`, or any capitalisation. The first matching column is used.

Usage

```
read_close_series(file, close_col = "close")
```

Arguments

<code>file</code>	Path to the CSV file.
<code>close_col</code>	Name of the close-price column (default "close").

Value

A numeric vector of finite close prices (length ≥ 10).

run_kronx

*Run the full Clock of Regimes (KRONX) analysis.***Description**

Runs the KRONX pipeline on either a CSV file of prices or a numeric vector of returns supplied directly. When `file` is used, the function reads the CSV file, extracts the close-price column (case-insensitive match on "close" or "Close"), and computes log returns. When `x` is supplied, it is treated as a numeric return series and the file-ingestion step is skipped.

Usage

```
run_kronx(
  file = NULL,
  x = NULL,
  close_col = "close",
  K = 3L,
  n_starts = 5L,
  max_iter = 200L,
  tol = 1e-06,
  seed = 123L,
  epsilon_min = 0.01,
  c_hazard = 0.05,
  tail_alpha = 0.01,
  ruin_horizon = 250L,
  nu_grid = c(3:30, 40, 60, 100),
  verbose = TRUE,
  output_dir = "kronx_output"
)
```

Arguments

<code>file</code>	Path to a CSV file containing a close-price column. Ignored if <code>x</code> is supplied. Default: NULL.
<code>x</code>	Optional numeric vector of returns. If supplied, <code>file</code> is ignored and no CSV is read. This is intended in particular for small, self-contained examples and tests. Default: NULL.
<code>close_col</code>	Name of the close-price column. The function first tries the exact name, then a case-insensitive match, and finally falls back to any column whose name contains "close". Default: "close".
<code>K</code>	Number of hidden states. Default: 3L.
<code>n_starts</code>	Number of EM random restarts. Default: 5L.
<code>max_iter</code>	Maximum EM iterations per restart. Default: 200L.
<code>tol</code>	Log-likelihood convergence tolerance. Default: 1e-6.
<code>seed</code>	Random seed for reproducibility. Default: 123L.

epsilon_min	Minimum baseline Talebian hazard. Default: 0.01.
c_hazard	Hazard sensitivity to tail thickness. Default: 0.05.
tail_alpha	Left-tail probability used for the empirical loss threshold. Default: 0.01.
ruin_horizon	Horizon, in observations, used in the risk bound. Default: 250L.
nu_grid	Candidate degrees-of-freedom values for Student-t fitting. Default: c(3:30, 40, 60, 100).
verbose	Logical; if TRUE, print progress and a summary. Default: TRUE.
output_dir	Directory for output files. Created if it does not exist. Pass NULL to suppress file output. Default: "kronx_output".

Details

The function then fits Gaussian and Student-t Hidden Markov Models (HMMs), builds the KRONX operator chain $Q \rightarrow K \rightarrow N$, and computes a residence-weighted upper bound on extreme downside risk. Results are returned as a named list and, optionally, written to output_dir.

Value

A named list containing:

close_px Numeric vector of raw close prices, or NULL when x is supplied directly.

ret Numeric vector of log returns or supplied returns.

K Number of hidden states.

gauss_fit Fitted Gaussian HMM object.

t_fit Fitted Student-t HMM object.

A_gauss Gaussian transition matrix.

A_t Student-t transition matrix.

epsilon Per-state Talebian hazard vector.

Q Hazard-adjusted operator.

K_mat KRONX generator matrix.

N_mat Fundamental matrix.

pi_qs Quasi-stationary distribution.

pi_res Residence-weight vector.

loss_threshold Empirical left-tail return threshold.

q_state Per-state tail probability.

bar_q Residence-weighted tail probability.

bar_lambda Residence-weighted hazard.

ruin_bound Upper bound over ruin_horizon.

tail_alpha The tail_alpha value used.

ruin_horizon The ruin_horizon value used.

state_summary A data.frame summarising per-state quantities.

vpath_t Integer vector of Viterbi-decoded Student-t state labels.

output_files Character vector of paths to written output files, or NULL if output_dir is NULL.

input_source A short label describing the data source used.

Examples

```

# Small self-contained example suitable for automatic checking
set.seed(123)
x <- rnorm(120, mean = 0, sd = 0.01)
res <- run_kronx(
  x = x,
  K = 2L,
  n_starts = 1L,
  max_iter = 10L,
  tol = 1e-4,
  tail_alpha = 0.05,
  ruin_horizon = 25L,
  verbose = FALSE,
  output_dir = NULL
)
res$ruin_bound
dim(res$A_t)
# Self-contained file-based example
tmp <- tempfile(fileext = ".csv")
dat <- data.frame(
  date = sprintf("2026-01-%02d", 1:20),
  close = c(
    100.0, 100.2, 100.1, 100.5, 100.4,
    100.8, 101.0, 100.9, 101.3, 101.1,
    101.6, 101.5, 101.9, 102.0, 101.8,
    102.2, 102.4, 102.3, 102.7, 102.9
  )
)
utils::write.csv(dat, tmp, row.names = FALSE)
res_file <- run_kronx(
  file = tmp,
  close_col = "close",
  K = 2L,
  n_starts = 1L,
  max_iter = 8L,
  tol = 1e-4,
  tail_alpha = 0.10,
  ruin_horizon = 10L,
  verbose = FALSE,
  output_dir = NULL
)
res_file$ruin_bound

```

viterbi_decode

Decode the most likely hidden-state path via the Viterbi algorithm.

Description

Decode the most likely hidden-state path via the Viterbi algorithm.

Usage

```
viterbi_decode(x, fit)
```

Arguments

<code>x</code>	Numeric vector of observations (log returns).
<code>fit</code>	A fitted HMM object returned by fit_hmm_em .

Value

An integer vector of length `length(x)` with state labels (1-indexed).

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