

Package ‘ringSeg’

June 25, 2026

Type Package

Title Asymptotic Distribution-Free Change-Point Detection via a New Ranking Scheme (RING)

Version 0.1.0

Description Rank-based, asymptotic distribution-free change-point detection for modern (high-dimensional, non-Euclidean) data, based on the graph-induced ranking scheme of Zhou and Chen (2025) <[doi:10.1109/TIT.2025.3575858](https://doi.org/10.1109/TIT.2025.3575858)>. Given a rank matrix built from a pairwise similarity, the method scans for a single change-point or a changed interval using three statistics (weighted 'WR', max-type 'MR', and generalized 'TR') and returns analytic distribution-free p-value approximations (with an optional skewness correction) as well as optional permutation p-values.

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Encoding UTF-8

Imports stats

NeedsCompilation no

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Repository CRAN

Date/Publication 2026-06-25 11:30:02 UTC

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ringSeg-package	<i>ringSeg: rank-based asymptotic distribution-free change-point detection</i>
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Description

Implements the RING change-point detector (Zhou & Chen, 2025, IEEE TIT): a rank-based, asymptotic distribution-free scan for a single change-point or a changed interval in a sequence of (possibly high-dimensional / non-Euclidean) observations. The method operates on a rank matrix built from a pairwise similarity and returns the weighted (WR), max-type (MR), and generalized (TR) statistics with analytic distribution-free p-value approximations (optionally skewness-corrected) and optional permutation p-values.

Details

Main entry points: [ring_cpd](#) (data / distance / rank-matrix in), [rcpd](#) (rank matrix in), [ring_graph](#) (build the RING k-NN rank graph), [Rise_Rank](#) (low-level ranker).

Author(s)

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References

Zhou, D. and Chen, H. (2025). Asymptotic Distribution-Free Change-Point Detection for Modern Data Based on a New Ranking Scheme. *IEEE Transactions on Information Theory*, **71**(8), 6183–6197. doi:10.1109/TIT.2025.3575858.

rcpd	<i>RING rank-based change-point detection (rank matrix in)</i>
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Description

Core RING detector operating directly on a rank matrix. The analytic p-value approximations are distribution-free and require no permutation; they assume the sparse RING k-NN graph, so build R with [ring_graph](#), or call [ring_cpd](#) to build it for you.

Usage

```
rcpd(R, n0 = NULL, n1 = NULL, pval.appr = TRUE, skew.corr = TRUE,
      B = 0, alternative = c("single", "interval"))
```

Arguments

R	an $n \times n$ rank matrix with zero diagonal, as produced by <code>ring_graph</code> (the RING k-NN rank graph). Observations (nodes) are indexed in time order.
n0, n1	scan range; defaults <code>ceiling(0.05*n)</code> and <code>floor(0.95*n)</code> , clamped to <code>[2, n-2]</code> . For <code>alternative = "interval"</code> these are the minimum (l0) and maximum (l1) interval lengths.
pval.appr	logical; compute analytic distribution-free p-value approximations for the WR, MR and TR statistics.
skew.corr	logical; additionally compute the skewness-corrected approximation (<code>WR.cor</code> , <code>MR.cor</code>). The skewness-corrected p-values are better calibrated at finite n ; the uncorrected Gaussian/field approximation can be anti-conservative for small n .
B	number of permutations for permutation p-values ($\emptyset = \text{none}$).
alternative	"single" for a single change-point, or "interval" for a changed interval.

Value

A list containing	
scanZ	the scan statistics. For <code>alternative = "single"</code> , each of TR (generalized, $Z_w^2 + Z_{\text{diff}}^2$), MR (max-type, $\max(Z_{\text{diff}} , Z_w)$) and WR (weighted, Z_w) holds the full scan curve, the estimated change-point tau, and the maximum.
pval.appr	(if <code>pval.appr</code>) analytic p-values TR, MR, WR, and (if <code>skew.corr</code>) the skewness-corrected <code>WR.cor</code> , <code>MR.cor</code> .
pval.perm	(if $B > \emptyset$) permutation p-values for TR, MR, WR.

References

Zhou, D. and Chen, H. (2025). Asymptotic Distribution-Free Change-Point Detection for Modern Data Based on a New Ranking Scheme. *IEEE Transactions on Information Theory*, **71**(8), 6183–6197. doi:10.1109/TIT.2025.3575858.

See Also

[ring_cpd](#), [Rise_Rank](#)

Examples

```
set.seed(1)
n <- 150; d <- 8
X <- matrix(rnorm(n * d), n, d)
X[76:n, ] <- X[76:n, ] + 0.8
R <- ring_graph(as.matrix(dist(X)), k = 13)
res <- rcpd(R, B = 0)
res$scanZ$TR$tau
res$pval.appr$TR
```

ring_cpd	<i>RING change-point detection from data or a distance matrix</i>
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Description

Convenience wrapper: builds the RING rank graph from the input (unless a rank matrix is supplied) and calls `rcpd`. Observations must be in time order.

Usage

```
ring_cpd(x, is.distance = FALSE, is.rank = FALSE, k = NULL,
         dist.method = "euclidean",
         n0 = NULL, n1 = NULL, pval.appr = TRUE, skew.corr = TRUE,
         B = 0, alternative = c("single", "interval"))
```

Arguments

x	One of: an $n \times d$ data matrix (rows = time-ordered observations; the default), an $n \times n$ distance matrix (<code>is.distance = TRUE</code>), or an $n \times n$ rank matrix (<code>is.rank = TRUE</code>).
is.distance	logical; if TRUE, x is a distance matrix.
is.rank	logical; if TRUE, x is already a rank matrix (e.g. from <code>ring_graph</code>) and is used as-is.
k	number of nearest neighbours for the RING k-NN graph (default <code>round(n^0.65)</code>).
dist.method	distance passed to <code>dist</code> when x is a data matrix (default "euclidean").
n0, n1	scan range (defaults <code>ceiling(0.05*n) / floor(0.95*n)</code>); for alternative = "interval" these are the minimum / maximum interval lengths).
pval.appr	logical; compute analytic p-value approximations.
skew.corr	logical; also compute the skewness-corrected approximation.
B	number of permutations for permutation p-values (\emptyset = none).
alternative	"single" (a single change-point) or "interval" (a changed interval).

Value

A list with `scanZ` (the WR / MR / TR statistics and estimated change-point(s)) and, as requested, `pval.appr` and `pval.perm`. See `rcpd`.

References

Zhou, D. and Chen, H. (2025). Asymptotic Distribution-Free Change-Point Detection for Modern Data Based on a New Ranking Scheme. *IEEE Transactions on Information Theory*, **71**(8), 6183–6197. doi:10.1109/TIT.2025.3575858.

See Also

[ring_graph](#), [rcpd](#), [Rise_Rank](#)

Examples

```

set.seed(1)
n <- 200; d <- 10; tau <- 100
X <- matrix(rnorm(n * d), n, d)
X[(tau + 1):n, ] <- X[(tau + 1):n, ] * 1.6 # a dispersion change at t = 100
res <- ring_cpd(X, skew.corr = TRUE)
res$scanZ$TR$tau
res$pval.appr$TR

```

ring_graph

Build a RING rank graph from a distance matrix

Description

Constructs the sparse, rank-based k-nearest-neighbour graph that the RING statistics operate on – RING’s ranking scheme: rank each observation’s neighbours within its row of the similarity $S = \max(D) - D$, keep the k nearest (weights k..1 from nearest to k-th), and symmetrize.

Usage

```
ring_graph(D, k = NULL)
```

Arguments

D	an $n \times n$ distance matrix.
k	number of nearest neighbours (default $\text{round}(n^{0.65})$, a value in the k-range used by Zhou & Chen).

Value

An $n \times n$ rank matrix with zero diagonal, suitable as the R argument of [rcpd](#).

See Also

[ring_cpd](#), [rcpd](#), [Rise_Rank](#)

Examples

```

set.seed(1)
X <- matrix(rnorm(60 * 5), 60, 5)
R <- ring_graph(as.matrix(dist(X)), k = 8)
dim(R)

```

Rise_Rank*Build a rank matrix from a similarity matrix*

Description

Low-level ranker for the RING statistics: turns a similarity matrix into a rank matrix. `method = "row"` is the per-row ranking used to build the sparse RING k-NN graph. For change-point detection, build the `R` argument of `rcpd` with `ring_graph` (the validated sparse graph); the analytic p-value theory assumes that graph rather than a dense "overall" ranking.

Usage

```
Rise_Rank(S, method = c("overall", "row"))
```

Arguments

<code>S</code>	an $n \times n$ similarity matrix (larger = more similar; e.g. the negative of a distance matrix).
<code>method</code>	"overall" ranks all distinct pairs jointly (the symmetric rank matrix is returned); "row" ranks within each row.

Value

An $n \times n$ rank matrix with zero diagonal.

See Also

[rcpd](#), [ring_cpd](#)

Examples

```
set.seed(1)
X <- matrix(rnorm(50 * 5), 50, 5)
R <- Rise_Rank(-as.matrix(dist(X)), method = "overall")
dim(R)
```

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