

# Package ‘rid’

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**Title** Multiple Change-Point Detection in Multivariate Time Series

**Version** 0.0.1

**Description** Provides efficient functions for detecting multiple change points in multidimensional time series. The models can be piecewise constant or polynomial. Adaptive threshold selection methods are available, see Fan and Wu (2024)  [<arXiv:2403.00600>](https://arxiv.org/abs/2403.00600).

**License** GPL-3

**Encoding** UTF-8

**Depends** purrr, CircularSilhouette, pracma

**NeedsCompilation** yes

**RoxygenNote** 7.2.1

**LinkingTo** Rcpp, RcppEigen

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## R topics documented:

List2Matrix	2
localization	2
rid	3
<b>Index</b>	<b>6</b>

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List2Matrix

*Convert a list of matrices into a single large matrix*


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**Description**

Convert a list of matrices into a single large matrix

**Usage**

```
List2Matrix(x, sym = FALSE)
```

**Arguments**

**x** A numeric list with each entity be a numeric matrix with p rows and q columns

**sym** A logical scalar representing whether each matrix is symmetric. If true, the duplicated half is removed

**Value**

A numeric matrix with pq rows and T columns

**Examples**

```
x=list(x1=1:3,x2=4:6)
List2Matrix(x)

y=list(y1=matrix(1:4,2),y2=matrix(5:8,2))
List2Matrix(y)
```

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localization

*Localization procedure*


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**Description**

The localization procedure to detect change-points.

**Usage**

```
localization(data, intervals, l = 0, scaling = FALSE, q = 1)
```

**Arguments**

data	A numeric matrix of observations with each horizontal axis being time, and each column being the multivariate time series
intervals	A numeric matrix of intervals with each row be a vector representing the interval
l	A non-negative integer of order of polynomial ( $l=0$ means piecewise constant)
scaling	A logical scalar representing whether to perform refinement for locally stationary data. Only useful when $l=0$
q	A positive integer of norm

**Value**

The positions of estimated change-points

**Examples**

```
set.seed(0)
data=rep(c(0,2,0),each=40)+rnorm(120)
d=rid(data,M=1000,tau="clustering")
cpt=localization(data,d$Good_Intervals)
print(cpt)
```

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rid

*Random intervals distillation procedure*

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**Description**

Distilled intervals that cover change-points are constructed.

**Usage**

```
rid(
  data,
  M = 1000,
  l = 0,
  scaling = FALSE,
  q = 1,
  intervals = NULL,
  tau = c("clustering", "ref"),
  bw = "nrd0",
  adjust = 0.5,
  k.max = 4,
  adj = 1.3
)
```

**Arguments**

data	A numeric matrix of observations with each horizontal axis being time, and each column being the multivariate time series
M	A positive integer of random intervals, used only when intervals=NULL
l	A non-negative integer of order of polynomial (l=0 means piecewise constant)
scaling	A logical scalar representing whether to perform refinement for locally stationary data. Only useful when l=0
q	A positive integer of norm
intervals	A numeric matrix of intervals with each row be a vector representing the interval. If intervals=NULL, random intervals are sampled
tau	A non-negative number representing the threshold of detection. If tau="clustering" (only useful when l=0), a clustering-based adaptive approach is applied. If tau="ref", a method based on simulated reference values is applied
bw	A parameter passed into function <a href="#">density</a> . Only useful when tau="clustering"
adjust	A parameter passed into function <a href="#">density</a> . Only useful when tau="clustering"
k.max	A positive integer representing the maximum value of clusters in threshold determining. Only useful when tau="clustering"
adj	A positive number used to multiply onto the threshold tau, providing threshold adjustments for small sample size

**Value**

A list containing:

Good_Intervals	A numeric matrix with each row being an interval that covers a change-point
Threshold	A positive number of the threshold

**See Also**

[localization](#)

**Examples**

```
## An example for the univariate case
set.seed(0)
data=rep(c(0,2,0),each=40)+rnorm(120)
d=rid(data,M=1000,tau="clustering")
cpt=localization(data,d$Good_Intervals)
print(cpt)
```

```
## An example for the multivariate case
set.seed(0)
data1=rep(c(0,2,0),each=40)+rt(120,8)
data2=rep(c(0,2,0),each=40)+rnorm(120)
data=rbind(data1,data2)
d=rid(data,M=1000,tau="clustering")
cpt=localization(data,d$Good_Intervals)
```

```

print(cpt)

## An example for the piecewise polynomial case
set.seed(0)
n=300
cp=c(0,round(n/3),round(2*n/3),n)
mu=matrix(c(0.004,-0.1,0,-0.01,0.02,0,0.01,-0.04,0),nrow=3,byrow = TRUE)
mu1=mu[1,1]*(1:n)^2+mu[1,2]*(1:n)+mu[1,3]
for(j in 2:3){
  index=which((1:n)-cp[j]>0)
  tmp1=(1:n)-cp[j]
  tmp=mu[j,1]*tmp1^2+mu[j,2]*tmp1+mu[j,3]
  tmp[1:(index[1]-1)]=0
  mu1=mu1+tmp
}
data=mu1+runif(n,-6,6)
plot(data,type="l")
d=rid(data,M=500,tau="ref",l=2)
cpt=localization(data,d$Good_Intervals,l=2)
print(cpt)

## An example for refinement in the locally stationary time series
set.seed(0)
n=1000
cp=c(0,round(n/4),round(3*n/4),n)
epsilon=rnorm(500+n,0,1)
ei=rep(0,500+n)
for(j in 2:(500+n)){ei[j]=0.5*ei[j-1]+epsilon[j]}
x=ei[(501):(500+n)]
lrv=purrr::map_dbl(1:n,function(j){sqrt(max(1,2000*j/n))})
x=x*lrv
x=x+c(rep(0,round(n/4)),rep(20,round(n/2)),rep(-20,n-round(n/4)-round(n/2)))
data=x
plot(data,type="l")
d=rid(data,M=1000,scaling = TRUE,tau="clustering")
cpt=localization(data,d$Good_Intervals)
print(cpt)

```

# Index

density, [4](#)

List2Matrix, [2](#)

localization, [2](#), [4](#)

rid, [3](#)