

# Package ‘tensorsparse’

September 27, 2020

**Type** Package

**Title** Multiway Clustering via Tensor Block Models

**Version** 3.0

**Date** 2020-09-27

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**Imports** parallel, stats

**Suggests** cluster

**Description** Implements the multiway sparse clustering approach of M. Wang and Y. Zeng, “Multi-way clustering via tensor block models”. Advances in Neural Information Processing System 32 (NeurIPS), 715-725, 2019.

**License** GPL (>= 2)

**NeedsCompilation** no

**Repository** CRAN

**Date/Publication** 2019-09-27 05:40:05 UTC

**RoxygenNote** 7.0.0

**Encoding** UTF-8

## R topics documented:

chooseClusteringSize . . . . .	2
chooseLambda . . . . .	3
getOrder3Tensor . . . . .	3
getOrder4Tensor . . . . .	5
tbmClustering . . . . .	6
<b>Index</b>	<b>8</b>

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chooseClusteringSize    *Select the clustering size for order-3 sparse tensor clustering via BIC*

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### Description

Select the clustering size for three-way clustering. The function searches over a range of clustering sizes and outputs the one that minimizes BIC. The clustering size  $(d_1, d_2, d_3)$  is a length-3 vector consisting of the number of clusters in each mode.

### Usage

```
chooseClusteringSize(
  x,
  k,
  r,
  l,
  lambda = 0,
  sim.times = 1,
  method = "L0",
  n.cores = NULL
)
```

### Arguments

x	a three-dimensional array
k	a vector, the possible numbers of clusters at mode 1
r	a vector, the possible numbers of clusters at mode 2
l	a vector, the possible numbers of clusters at mode 3
lambda	a numeric value, regularization coefficient
sim.times	the number of simulation replicates when performing clustering
method	two options: "L0", "L1". "L0" indicates L0 penalty, and "L1" indicates Lasso penalty
n.cores	the number of cores in parallel implementation

### Value

a list

estimated\_krl a 1\*3 matrix consisting of the estimated clustering size

BIC a vector consisting of the BIC value for all combinations of clustering sizes

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chooseLambda	<i>Select the regularization coefficient for order-3 sparse tensor clustering via BIC</i>
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### Description

Select the regularization coefficient for three-way clustering. The clustering size is assumed to be known. The function searches over a range of regularization sizes and outputs the one that minimizes the BIC.

### Usage

```
chooseLambda(x, k, r, l, lambda = NULL, method = "L0")
```

### Arguments

x	a three-dimensional array
k	an positive integer, the numbers of clusters at mode 1
r	an positive integer, the numbers of clusters at mode 2
l	an positive integer, the numbers of clusters at mode 3
lambda	a vector of possible lambda, eg: lambda = c(0,50,100,200)
method	two options: "L0", "L1". "L0" indicates L0 penalty, and "L1" indicates Lasso penalty

### Value

a list

lambda the lambda with lowest BIC

BIC the BIC for each lambda in the given range

nonzeromus the number of clusters with non-zero means

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getOrder3Tensor	<i>Generate a random order-3 tensor</i>
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---

### Description

Generate an order-3 random tensor based on tensor block model.

### Usage

```
getOrder3Tensor(
  n,
  p,
  q,
  k = NULL,
  r = NULL,
  l = NULL,
```

```

    error = 3,
    sort = TRUE,
    sparse.percent = 0,
    center = FALSE,
    seed = NULL,
    mumin = -3,
    mumax = 3
  )

```

### Arguments

n	the dimension at mode 1
p	the dimension at mode 2
q	the dimension at mode 3
k	an positive integer, the numbers of clusters at mode 1
r	an positive integer, the numbers of clusters at mode 2
l	an positive integer, the numbers of clusters at mode 3
error	a positive numeric value, noise level
sort	if TRUE, the tensor entries belonging to the same cluster would be assumed together
sparse.percent	the proportion of zero entries based on the Gaussian tensor block model
center	if True, the data tensor would be centered to zero-mean before clustering
seed	a positive integer, used to specify the random seed
mumin	a numeric value, the lower bound of the block mean
mumax	a numeric value, the upper bound of the block mean

### Value

a list

x the tensor

truthX the underlying signal tensor following block model

truthCs true cluster label assignment at mode 1

truthDs true cluster label assignment at mode 2

truthEs true cluster label assignment at mode 3

mus the block means

binaryX the 0-1 tensor (0:the mean signal = 0; 1:the mean signal != 0)

### Examples

```
getOrder3Tensor(20,20,20,2,2,2)$x
```

getOrder4Tensor

*Generate a random order-4 tensor***Description**

Generate a random order-4 tensor based on tensor block model.

**Usage**

```
getOrder4Tensor(
  n,
  p,
  q,
  s,
  k = NULL,
  r = NULL,
  l = NULL,
  m = NULL,
  error = 3,
  sort = TRUE,
  sparse.percent = 0,
  center = FALSE,
  seed = NULL,
  mumin = -3,
  mumax = 3
)
```

**Arguments**

n	the dimension at mode 1
p	the dimension at mode 2
q	the dimension at mode 3
s	the dimension at mode 4
k	an positive integer, the numbers of clusters at mode 1
r	an positive integer, the numbers of clusters at mode 2
l	an positive integer, the numbers of clusters at mode 3
m	an positive integer, the numbers of clusters at mode 4
error	a positive numeric value, noise level
sort	if TRUE, the tensor entries belonging to the same cluster would be assumed together
sparse.percent	the proportion of zero entries based on the Gaussian tensor block model
center	if True, the data tensor would be centered to zero-mean before clustering
seed	a positive integer, used to specify the random seed
mumin	a numeric value, the lower bound of the block mean
mumax	a numeric value, the upper bound of the block mean

**Value**

a list  
 x the tensor  
 truthX the underlying signal tensor following block model  
 truthCs true cluster label assignment at mode 1  
 truthDs true cluster label assignment at mode 2  
 truthEs true cluster label assignment at mode 3  
 truthFs true cluster label assignment at mode 4  
 mus the block means  
 binaryX the 0-1 tensor (0:the mean signal = 0; 1:the mean signal != 0)

**Examples**

```
getOrder4Tensor(10,10,10,10,2,2,2,2)
```

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tbmClustering	<i>Perform tensor clustering via tensor block model (TBM)</i>
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**Description**

Perform tensor clustering via tensor block model (TBM) method.

**Usage**

```
tbmClustering(
  x,
  k,
  r,
  l,
  lambda = 0,
  max.iter = 1000,
  threshold = 1e-10,
  sim.times = 1,
  trace = FALSE,
  Cs.init = NULL,
  Ds.init = NULL,
  Es.init = NULL,
  method = "L0"
)
```

**Arguments**

x	an order-3 data tensor
k	an positive integer, the numbers of clusters at mode 1
r	an positive integer, the numbers of clusters at mode 2
l	an positive integer, the numbers of clusters at mode 3
lambda	a numeric value, regularization coefficient

<code>max.iter</code>	a positive integer, the maximum numbers of iteration
<code>threshold</code>	a positive small numeric value for convergence threshold
<code>sim.times</code>	the number of simulation replicates when performing clustering
<code>trace</code>	logic value, print result per each iteration if TRUE
<code>Cs.init</code>	vector or NULL, initial cluster label assignment at mode 1
<code>Ds.init</code>	vector or NULL, initial cluster label assignment at mode 2
<code>Es.init</code>	vector or NULL, initial cluster label assignment at mode 3
<code>method</code>	two options: "L0", "L1". "L0" indicates L0 penalty, and "L1" indicates Lasso penalty

**Value**

a list

judgeX estimated underlying signal tensor

Cs clustering result at mode 1

Ds clustering result at mode 2

Es clustering result at mode 3

mus estimated block means

**Author(s)**

Yuchen Zeng <yzeng58@wisc.edu>

**References**

M. Wang and Y. Zeng, "Multiway clustering via tensor block models". Advances in Neural Information Processing System 32 (NeurIPS), 715-725, 2019.

**Examples**

```
x = getOrder3Tensor(20,20,20,2,2,2)$x
tbmClustering(x,2,2,2)
```

# Index

chooseClusteringSize, [2](#)  
chooseLambda, [3](#)

getOrder3Tensor, [3](#)  
getOrder4Tensor, [5](#)

tbmClustering, [6](#)