

# Package ‘TDbasedUFE’

September 16, 2024

**Type** Package

**Title** Tensor Decomposition Based Unsupervised Feature Extraction

**Version** 1.4.0

**Description** This is a comprehensive package to perform  
Tensor decomposition based unsupervised feature extraction.  
It can perform unsupervised feature extraction.  
It uses tensor decomposition.  
It is applicable to gene expression, DNA methylation, and  
histone modification etc.  
It can perform multiomics analysis.  
It is also potentially applicable to single cell omics data sets.

**biocViews** GeneExpression, FeatureExtraction, MethylationArray,  
SingleCell

**License** GPL-3

**Encoding** UTF-8

**LazyData** false

**URL** <https://github.com/tagtag/TDbasedUFE>

**BugReports** <https://github.com/tagtag/TDbasedUFE/issues>

**Imports** GenomicRanges, rTensor, readr, methods, MOFadata, tximport,  
tximportData, graphics, stats, utils, shiny

**RoxygenNote** 7.2.3

**Roxygen** list(markdown = TRUE)

**Suggests** BiocStyle, knitr, rmarkdown, testthat (>= 3.0.0)

**VignetteBuilder** knitr

**Config/testthat/edition** 3

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TDbasedUFE-package	<i>TDbasedUFE: Tensor Decomposition Based Unsupervised Feature Extraction</i>
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## Description

This is a comprehensive package to perform Tensor decomposition based unsupervised feature extraction. It can perform unsupervised feature extraction. It uses tensor decomposition. It is applicable to gene expression, DNA methylation, and histone modification etc. It can perform multiomics analysis. It is also potentially applicable to single cell omics data sets.

## Author(s)

**Maintainer:** Y-h. Taguchi <tag@granular.com> ([ORCID](https://orcid.org/0000-0003-0867-8986))

## See Also

Useful links:

- <https://github.com/tagtag/TDbasedUFE>
- Report bugs at <https://github.com/tagtag/TDbasedUFE/issues>

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computeHosvd	<i>Title Compute higher order singular value decomposition</i>
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**Description**

Title Compute higher order singular value decomposition

**Usage**

```
computeHosvd(Z, dims = c(10, dim(attr(Z, "value"))[-1]), scale = TRUE)
```

**Arguments**

Z	array that includes omics data
dims	dimensions to be computed by HOSVD
scale	If value is scaled

**Value**

List that includes output from HOSVD

**Examples**

```
Z <- PrepareSummarizedExperimentTensor(
  sample=matrix(as.character(seq_len(6)),c(3,2)),
  feature=as.character(seq_len(10)),
  value=array(runif(10*3*2),c(10,3,2)))
HOSVD <- computeHosvd(Z)
```

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computeHosvdSquire	<i>Title Compute higher order singular value decomposition from the tensor generated from squared matrix</i>
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**Description**

Title Compute higher order singular value decomposition from the tensor generated from squared matrix

**Usage**

```
computeHosvdSquire(
  Z,
  dims = unlist(lapply(dim(attr(Z, "value")), function(x) {
    min(10, x)
  })),
  scale = TRUE
)
```

**Arguments**

Z	A tensor including sample names, feature values, associated with featureRange and sample properties
dims	dimensions to be computed by HOSVD
scale	If value is scaled

**Value**

List that includes output from HOSVD

**Examples**

```
omics1 <- matrix(runif(100),10)
dimnames(omics1) <- list(seq_len(10),seq_len(10))
omics2 <- matrix(runif(100),10)
dimnames(omics2) <- dimnames(omics1)
Multi <- list(omics1,omics2)
Z <- PrepareSummarizedExperimentTensorSquare(
  sample=matrix(colnames(omics1),1),
  feature=list(omics1=rownames(omics1),
    omics2=rownames(omics2)),
  value=convertSquare(Multi),
  sampleData=list(NA))
HOSVD <- computeHosvdSquire(Z)
```

---

convertSquare

*Generate squared tensor from multiomics data*

---

**Description**

Generate squared tensor from multiomics data

**Usage**

```
convertSquare(Multi)
```

**Arguments**

Multi	A list that include multiomics data
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**Value**

A tensor computed from multiomics data

**Examples**

```
omics1 <- matrix(runif(100),10)
dimnames(omics1) <- list(seq_len(10),seq_len(10))
omics2 <- matrix(runif(100),10)
dimnames(omics2) <- dimnames(omics1)
Multi <- list(omics1,omics2)
Z <- convertSquare(Multi)
```

---

```
PrepareSummarizedExperimentTensor
```

*Title Generate feature values formatted as a tensor format*

---

**Description**

Title Generate feature values formatted as a tensor format

**Usage**

```
PrepareSummarizedExperimentTensor(
  sample,
  feature,
  value,
  featureRange = GRanges(NULL),
  sampleData = list(NULL)
)
```

**Arguments**

sample	Sample names
feature	Feature id names
value	Feature values
featureRange	Genomic coordinate attributed to feature id (if any)
sampleData	Sample property (labels etc)

**Value**

A tensor including sample names, feature id, feature values, associated with featureRange and sample properties

**Examples**

```
require(GenomicRanges)
Z <- PrepareSummarizedExperimentTensor(
  sample=matrix(as.character(seq_len(6)),c(3,2)),
  feature=as.character(seq_len(10)),
  value=array(runif(10*3*2),c(10,3,2)))
```

---

```
PrepareSummarizedExperimentTensorSquare
```

*Title Generate feature values formatted as a tensor format from Squared matrix*

---

## Description

Title Generate feature values formatted as a tensor format from Squared matrix

## Usage

```
PrepareSummarizedExperimentTensorSquare(
  sample = list(NULL),
  feature,
  value,
  featureRange = GRanges(NULL),
  sampleData = list(NULL)
)
```

## Arguments

sample	Sample names
feature	Feature id names
value	Squared Feature values
featureRange	Genomic coordinate attributed to feature id (if any)
sampleData	Sample property (labels etc)

## Value

A tensor including sample names, feature values, associated with featureRange and sample properties

## Examples

```
omics1 <- matrix(runif(100),10)
dimnames(omics1) <- list(seq_len(10),seq_len(10))
omics2 <- matrix(runif(100),10)
dimnames(omics2) <- dimnames(omics1)
Multi <- list(omics1,omics2)
Z <- PrepareSummarizedExperimentTensorSquare(
  sample=matrix(colnames(omics1),1),
  feature=list(omics1=rownames(omics1),
  omics2=rownames(omics2)),
  value=convertSquare(Multi),
  sampleData=list(NA))
```

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selectFeature	<i>Title Select features</i>
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**Description**

Title Select features

**Usage**

```
selectFeature(HOSVD, input_all, de = 1e-04, p0 = 0.01, breaks = 100)
```

**Arguments**

HOSVD	output from HOSVD
input_all	Selected singular value IDs
de	Initial value for optimization of standard deviation
p0	Threshold P-value
breaks	The number of bins

**Value**

List that includes selected features and computed P-value

**Examples**

```
set.seed(2)
require(rTensor)
HOSVD <- hosvd(as.tensor(array(runif(10000*3*3),c(10000,3,3))),c(10,3,3))
input_all <- c(2,2)
index <- selectFeature(HOSVD,input_all,de=0.01,p0=0.01)
```

---

selectFeatureSquare	<i>Title Select features (for tensor generated from squared matrix)</i>
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**Description**

Title Select features (for tensor generated from squared matrix)

**Usage**

```
selectFeatureSquare(
  HOSVD,
  input_all,
  Multi,
  de = rep(1e-04, dim(HOSVD$U[[3]])[2]),
  p0 = 0.01,
  breaks = 100,
  interact = TRUE
)
```

**Arguments**

HOSVD	output from HOSVD applied to tensor generated from squared matrix
input_all	Selected singular value vector IDs
Multi	Multiomics data
de	Initial value for optimization of standard deviation
p0	Threshold P-value
breaks	The number of bins
interact	if interact mode or not

**Value**

List that includes selected features and computed P-value

**Examples**

```
omics1 <- matrix(runif(100000),ncol=10)
dimnames(omics1) <- list(seq_len(10000),seq_len(10))
omics2 <- matrix(runif(100000),ncol=10)
dimnames(omics2) <- dimnames(omics1)
Multi <- list(omics1,omics2)
Z <- PrepareSummarizedExperimentTensorSquare(
  sample=matrix(colnames(omics1),1),
  feature=list(omics1=rownames(omics1),
  omics2=rownames(omics2)),
  value=convertSquare(Multi),
  sampleData=list(NA))
HOSVD <- computeHosvdSquare(Z)
cond <- list(0,rep(seq_len(2),each=5),c("A","B"))
input_all <- selectSingularValueVectorLarge(HOSVD,cond,input_all=c(1,1))
index <- selectFeatureSquare(HOSVD,input_all,Multi,de=c(0.1,0.1),
interact=FALSE)
```



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`selectSingularValueVectorLarge`*Title Select singular value vectors from HOSVD (boxplot version)*

---

**Description**

Title Select singular value vectors from HOSVD (boxplot version)

**Usage**

```
selectSingularValueVectorLarge(HOSVD, cond, input_all = NULL)
```

**Arguments**

HOSVD	output from HOSVD
cond	Labels to select singular value vector number
input_all	if list is not null, no interactive mode is activated but provided values are used.

**Value**

Selected singular value vector IDs

**Examples**

```
Z <- PrepareSummarizedExperimentTensor(  
  sample=matrix(as.character(seq_len(6)),c(3,2)),  
  feature=as.character(seq_len(10)),  
  value=array(runif(10*3*2),c(10,3,2)))  
HOSVD <- computeHosvd(Z)  
cond <- list(0,c("A","B","C"),c("A","B"))  
input_all <- selectSingularValueVectorLarge(HOSVD,cond,input_all=c(1,1))
```

---

`selectSingularValueVectorSmall`*Title Select singular value vectors from HOSVD*

---

**Description**

Title Select singular value vectors from HOSVD

**Usage**

```
selectSingularValueVectorSmall(HOSVD, input_all = NULL)
```

**Arguments**

HOSVD                output from HOSVD  
input\_all            if ist is no null, no interactive mode is activated but provided values are used.

**Value**

Selected singular value vector IDs

**Examples**

```
Z <- PrepareSummarizedExperimentTensor(
  sample=matrix(as.character(seq_len(6)),c(3,2)),
  feature=as.character(seq_len(10)),
  value=array(runif(10*3*2),c(10,3,2)))
HOSVD <- computeHosvd(Z)
input_all <- selectSingularValueVectorSmall(HOSVD,input_all=c(1,1))
```

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tableFeatures	<i>Title Show selected features as Table</i>
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**Description**

Title Show selected features as Table

**Usage**

```
tableFeatures(Z, index)
```

**Arguments**

Z                    Tensor of features  
index                List that includes selected features and P-values

**Value**

Table list of selected features

**Examples**

```
set.seed(2)
require(rTensor)
HOSVD <- hosvd(as.tensor(array(runif(10000*3*3),c(10000,3,3))),c(10,3,3))
input_all <- c(2,2)
index <- selectFeature(HOSVD,input_all,de=0.01,p0=0.01)
index$index[seq_len(100)] <- TRUE
Z <- PrepareSummarizedExperimentTensor(
  sample=matrix(as.character(seq_len(9)),c(3,3)),
  feature=as.character(seq_len(10000)),
  value=array(runif(10000*3*3),c(10,3,3)))
head(tableFeatures(Z,index))
```

---

tableFeaturesSquare	<i>Title Show selected features as Table (for Squared one)</i>
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**Description**

Title Show selected features as Table (for Squared one)

**Usage**

```
tableFeaturesSquare(Z, index, id)
```

**Arguments**

Z	Tensor of features
index	List that includes selected features and P-values
id	feature to be shown

**Value**

Table list of selected features

**Examples**

```
omics1 <- matrix(runif(100000),ncol=10)
dimnames(omics1) <- list(seq_len(10000),seq_len(10))
omics2 <- matrix(runif(100000),ncol=10)
dimnames(omics2) <- dimnames(omics1)
Multi <- list(omics1,omics2)
Z <- PrepareSummarizedExperimentTensorSquare(
  sample=matrix(colnames(omics1),1),
  feature=list(omics1=rownames(omics1),
  omics2=rownames(omics2)),
  value=convertSquare(Multi),
  sampleData=list(NA))
HOSVD <- computeHosvdSquare(Z)
cond <- list(0,rep(seq_len(2),each=5),c("A","B"))
input_all <- selectSingularValueVectorLarge(HOSVD,cond,input_all=c(1,1))
index <- selectFeatureSquare(HOSVD,input_all,Multi,de=c(0.1,0.1),
  interact=FALSE)
index[[1]]$index[1:100]<-TRUE
index[[1]]$p.value[1:100] <- 1e-3
tableFeaturesSquare(Z,index,1)
```

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