

# Package ‘omicade4’

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**Type** Package

**Title** Multiple co-inertia analysis of omics datasets

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**Imports** made4, Biobase

**Depends** R (>= 3.0.0), ade4

**Suggests** BiocStyle

**Description** This package performs multiple co-inertia analysis of omics datasets.

**Reference** Meng C, Kuster B, Culhane AC and Gholami AM. A multivariate approach to the integration of multi-omics datasets. *BMC Bioinformatics* (2014) (Manuscript accepted) Culhane AC, Thioulouse J, Perriere G, Higgins DG. (2005) MADE4: an R package for multivariate analysis of gene expression data. *Bioinformatics*. 21(11):2789-90. S. Dray and A.B. Dufour. (2007) The ade4 package: implementing the duality diagram for ecologists. *Journal of Statistical Software* 22(4):1-20.

**License** GPL-2

**LazyLoad** yes

**biocViews** Software, Clustering, Classification, MultipleComparison

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| omicade4-package | <i>multiple co-inertia analysis of omics datasets</i> |
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## Description

The main function in the package performing multiple co-inertia analysis on omics datasets

## Details

|           |            |
|-----------|------------|
| Package:  | omicade4   |
| Type:     | Package    |
| Version:  | 1.7.2      |
| Date:     | 2015-04-06 |
| License:  | GPL-2      |
| LazyLoad: | yes        |

Multiple co-inertia analysis (MCIA) is a multivariate analysis method that could be used to analyze multiple tables measuring the same set of individuals, this package provides a one-stop function for MCIA and functions for subsequent analysis especially for multiple omics datasets.

## Author(s)

Chen Meng, Aedin Culhane, Amin M. Gholami  
 Maintainer: Chen Meng <mengchen18@gmail.com>

## References

Meng C, Kuster B, Culhane AC and Gholami AM. A multivariate approach to the integration of multi-omics datasets. (Manuscript under preparation)

Culhane AC, Thioulouse J, Perriere G, Higgins DG. (2005) MADE4: an R package for multivariate analysis of gene expression data. *Bioinformatics*. 21(11):2789-90.

S. Dray and A.B. Dufour. (2007) The ade4 package: implementing the duality diagram for ecologists. *Journal of Statistical Software* 22(4):1-20.

## See Also

ade4 and package made4

**Examples**

```
data(NCI60_4arrays)
mci <- mci(NCI60_4arrays)
```

---

mci *multiple co-inertia analysis*

---

**Description**

The main function in omicade4. Performing multiple co-inertia analysis on a list of data.frames or matrix

**Usage**

```
mci(df.list, cia.nf = 2, cia.scan = FALSE, nsc = T, svd = TRUE)
## S3 method for class 'mci'
plot(x, axes = 1:2,
     sample.lab = TRUE, sample.legend = TRUE, sample.color = 1,
     phenovect = NULL, df.color = 1,
     df.pch = NA, gene.nlab = 0, ...)
```

**Arguments**

|               |  |
|---------------|--|
| df.list       | A list of data.frames, matrix or ExpressionSet is going to be analyzed, the column number must be the same and mapped across all data.frame/matrix   |
| cia.nf        | An integer indicating the number of kept axes  |
| cia.scan      | A logical indicating whether the co-inertia analysis eigenvalue (scree) plot should be shown so that the number of axes, (cia.nf) can be selected interactively. Default value is FALSE.   |
| nsc           | A logical indicating whether multiple co-inertia analysis should be performed using multiple non-symmetric correspondence analyses <code>dudi.nsc</code> . The default =TRUE is highly recommended. If FALSE, COA <code>dudi.coa</code> will be performed on the first data.frame, and row weighted COA <code>dudi.rwcoa</code> will be performed on the rest ones using the row weights from the first one. |
| svd           | A logical indicates which function should be used to perform singular value decomposition.   |
| sample.lab    | A logical indicating if the samples should be labelled, the default is TRUE.   |
| sample.color  | Defining colours of samples for plotting sample space, the length of this argument should be either one (uniform color) or the same with the column number of data.frame in df.list.   |
| sample.legend | A logical indicating if the legend for sample space should be drawn.   |
| df.color      | Defining the colours for plotting variables (genes) from different data.frame. The length of this argument should be either one (all datasets use the same colour) or the same number of datasets (each dataset has a specified colour, the repetitive use of colour code is allowed.)   |
| df.pch        | Defining the pch for plotting variable (gene) space. The default is NA, the function will distinguish datasets by default. Otherwise, the length of this argument should be either one (all datasets use the same pch) or the same number of datasets (each dataset has a specified pch).  |

|           |   |
|-----------|---|
| phenovec  | A factor for plotting sample space, phenovec could be used to distinguish individuals in the data.frames.     |
| x         | An object of class mcia   |
| axes      | A vector of integer in length 2 to indicate the axes are going to be plotted. The default are first two axes. |
| gene.nlab | An integer indicating how many top weighted genes on each axis should be labelled                             |
| ...       | Other arguments   |

### Details

The column number of data.frame in the df.list must be the same, and the same column from different data.frame should be matchable. For example, Microarray profiling for the same set of cell lines, patients and etc.

mcia calls `dudi.nsc`, `ktab` and `mcoa` in `ade4` packages.

#### Plotting and visualizing mcia results

Two functions could be used to visualize the result of mcia: The first is `plot.mcia`, which results in four plots. Top left represents the sample space. Individuals from the same column of different data.frames are linked by edges. Different platforms are distinguished by the shape of points. Top right shows the variable space, datasets are marked by different colours. Bottom left represents the eigenvalue scree plot. The pseudo-eigenvalue space of all data.frames are visualized in the bottom right panel. The second function is `plotVar.mcia`, which could be used to plot the variable space for different datasets as well as finding and visualizing the variables (genes) across datasets.

#### Other methods

`selectVar.mcia`: selecting variables (genes) according to the their coordinates.

### Value

|      |   |
|------|---|
| call | the function called   |
| mcoa | The results returned by <code>mcoa</code>   |
| coa  | The results returned by separate analysis (applying <code>dudi.nsc</code> or <code>dudi.coa</code> on each data.frame separately) |

### Author(s)

Chen Meng

### See Also

See Also as `mcoa`, `plotVar`, `plotVar`

### Examples

```
data(NCI60_4arrays)
mcoin <- mcia(NCI60_4arrays)
plot(mcoin, sample.lab=FALSE, df.col=4:7)

colcode <- sapply(strsplit(colnames(NCI60_4arrays$agilent), split="\\.\\.\\."),
  function(x) x[1])
plot(mcoin, sample.lab=FALSE, sample.color=as.factor(colcode))
```

---

|               |  |
|---------------|--|
| NCI60_4arrays | <i>Microarray gene expression profiles of the NCI 60 cell lines from 4 different platforms</i> |
|---------------|--|

---

## Description

The 60 human tumour cell lines are derived from patients with leukaemia, melanoma, lung, colon, central nervous system, ovarian, renal, breast and prostate cancers. The cell line panel is widely used in anti-cancer drug screen. In this dataset, a subset of microarray gene expression of the NCI 60 cell lines from four different platforms are combined in a list, which could be used as input to `mci` directly.

## Usage

```
data(NCI60_4arrays)
```

## Format

The format is: List of 4 `data.frame`s

- `\$agilent`: `data.frame` containing 300 rows and 60 columns. 300 gene expression log ratio measurements of the NCI60 cell lines, by Agilent platform.
- `\$hgu133`: `data.frame` containing 298 rows and 60 columns. 298 gene expression log ratio measurements of the NCI60 cell lines, by H-GU133 platform.
- `\$hgu133p2`: `data.frame` containing 268 rows and 60 columns. 268 gene expression log ratio measurements of the NCI60 cell lines, by H-GU133 plus 2.0 platform.
- `\$hgu95`: `data.frame` containing 288 rows and 60 columns. 288 gene expression log ratio measurements of the NCI60 cell lines, by H-GU95 platform.

## Source

Cell Miner <http://discover.nci.nih.gov/cellminer/>

## References

Reinhold WC, Sunshine M, Liu H, Varma S, Kohn KW, Morris J, Doroshow J, Pommier Y CellMiner: A Web-Based Suite of Genomic and Pharmacologic Tools to Explore Transcript and Drug Patterns in the NCI-60 Cell Line Set. *Cancer Research*. 2012 Jul, 15;72(14):3499-511

## Examples

```
data(NCI60_4arrays)
summary(NCI60_4arrays)
mcoin <- mci(NCI60_4arrays)
```

---

|         |   |
|---------|---|
| plotVar | <i>Plot variable (gene) spaces of result from MCIA or CIA</i> |
|---------|---|

---

### Description

The user level function for plotting variable space of `mcia` or `cia`, which could be used to visualize selected variables (genes) across datasets. It calls `plotVar.cia` or `plotVar.mcia`.

### Usage

```
plotVar(x, var = NA, axes = 1:2,
        var.col = "red", var.lab = FALSE, bg.var.col = "gray",
        nlab = 0, sepID.data=NULL, sepID.sep="_", ...)
```

### Arguments

|            |   |
|------------|---|
| x          | An object of class <code>cia</code> or <code>mcia</code>  |
| var        | A character vector defining the variables (genes) are going to be labelled and coloured. The default NA means no variables (genes) selected.  |
| axes       | An integer vector in length 2 indicating which axes are going to be plotted. Default are the first two axes.  |
| var.col    | The colour of selected variables (genes), the length of this argument should be either 1 (uniform colour) or the length of var (each var has a specified colour).   |
| var.lab    | A logical indicating if the variables (genes) selected should be labelled, the default is FALSE   |
| bg.var.col | Colour code for unselected variables (genes) in all datasets.   |
| nlab       | An integer indicating how many top weighted genes on each axis should be labelled.  |
| sepID.data | This argument enables a more generalized mapping of identifiers in different datasets. For example, if there is a PTM (post-transcriptional modification) dataset in one of the <code>data.frames</code> , the corresponding protein could be detected with setting this argument. For more details, see "details" section. |
| sepID.sep  | Used to help determine the separator of variables (genes) in the <code>sepID.data</code> . For more details, see "details" section.   |
| ...        | Other arguments   |

### Details

For the `sepID.data`, a typical example is the post-transcriptional modification (PTM) data. The name of variables (genes) have a general form like "proteinName\_modificationSite". The `sepID.data` specifies the IDs from dataset that should be separated, `sepID.sep` specifies the separator of protein name and modification site. This is used to determine the same proteins/genes across different datasets.

### Value

If `var` is not NA, a data frame is returned, with rows for variables (genes) of interest and columns of logical values indicating which dataset contains which variables (genes).

**Author(s)**

Chen Meng

**See Also**See Also as [plotVar.cia](#), [plotVar.mcia](#)**Examples**

```

data(NCI60_4arrays)
mcoin <- mcia(NCI60_4arrays)
plotVar(mcoin, var=c("S100B", "S100A1"), var.lab=TRUE)

# an example for the usage of sepID.data and sepID.sep
nci60_mod <- NCI60_4arrays
rownames(nci60_mod$hgu95) <- paste(rownames(nci60_mod$hgu95), "s1", sep="_")
mcoin_mod <- mcia(nci60_mod)
id <- split(rownames(mcoin_mod$mcoa$Tco), mcoin_mod$mcoa$TC$T)
sapply(id, function(x) head(x))

plotVar(mcoin_mod, var=c("S100B", "S100A1"), var.lab=TRUE, sepID.data=1:4, sepID.sep = c("\\.", "\\.", "\\.", "\\.", "\\.", "\\."))
plotVar(mcoin_mod, var=c("S100B", "S100A1"), var.lab=TRUE, sepID.data=4, sepID.sep="_")
plotVar(mcoin_mod, var=c("S100B", "S100A1"), var.lab=TRUE, sepID.data=1:3, sepID.sep="\\.")

```

---

**plotVar.cia***Plot variable space of result from [cia](#)*

---

**Description**Plot variable space of [mcia](#) and visualize selected variables across datasets.**Usage**

```

## S3 method for class 'cia'
plotVar(x, var = NA, axes = 1:2,
        var.col = "red", var.lab = FALSE, bg.var.col = "gray",
        nlab = 0, sepID.data = NULL, sepID.sep = "_", ...)

```

**Arguments**

|            |                                     |
|------------|-------------------------------------|
| x          | An object of class <code>cia</code> |
| var        | see <a href="#">plotVar</a>         |
| axes       | see <a href="#">plotVar</a>         |
| var.col    | see <a href="#">plotVar</a>         |
| var.lab    | see <a href="#">plotVar</a>         |
| bg.var.col | see <a href="#">plotVar</a>         |
| nlab       | see <a href="#">plotVar</a>         |

|            |                             |
|------------|-----------------------------|
| sepID.data | see <a href="#">plotVar</a> |
| sepID.sep  | see <a href="#">plotVar</a> |
| ...        | Other arguments             |

**Value**

If var is not NA, a data frame is return, with rows for variables of interest and columns of logical value indicating which data.frames contains which variables.

**Author(s)**

Chen Meng

**See Also**

See Also as [plotVar.mcia](#)

---

|              |  |
|--------------|--|
| plotVar.mcia | <i>Plot variable space of result from mcia</i> |
|--------------|--|

---

**Description**

Plot variable space of [mcia](#) and visualize selected variables across datasets, the function is called by plotVar.

**Usage**

```
## S3 method for class 'mcia'
plotVar(x, var = NA, axes = 1:2,
        var.col = "red", var.lab = FALSE, bg.var.col = "gray",
        nlab = 0, sepID.data=NULL, sepID.sep= "\\.",
        df = NA, layout = NA, ...)
```

**Arguments**

|            |   |
|------------|---|
| x          | An object of class mcia, the result returned by <a href="#">mcia</a> .                              |
| var        | see <a href="#">plotVar</a>   |
| axes       | see <a href="#">plotVar</a>   |
| var.col    | see <a href="#">plotVar</a>   |
| var.lab    | see <a href="#">plotVar</a>   |
| bg.var.col | see <a href="#">plotVar</a>   |
| nlab       | see <a href="#">plotVar</a>   |
| sepID.data | see <a href="#">plotVar</a>   |
| sepID.sep  | see <a href="#">plotVar</a>   |
| df         | Integers indicating which dataset should be plotted, the default NA means all datasets are plotted. |
| layout     | The layout of multiple plots.   |
| ...        | Other arguments   |

**Value**

If var is not NA, a data frame is return, with rows for variables of interest and columns of logical values indicating which data.frames contains which variables.

**Author(s)**

Chen Meng

**See Also**

See Also as [plotVar.cia](#), [plotVar](#)

**Examples**

```
data(NCI60_4arrays)
mcoin <- mcia(NCI60_4arrays)
plot.mcia(mcoin, sample.lab=FALSE, df.col=4:7)
plotVar(mcoin, var=NA, bg.var.col=1:4, var.lab=TRUE)
plotVar(mcoin, var=c("SPOPL", "CAPN2", "SNX8"),
        df=1:4, var.lab=TRUE, var.col=c("red", "green", "blue"))
```

```
data(NCI60_4arrays)
mcoin <- mcia(NCI60_4arrays)
plotVar(mcoin, var=c("S100B", "S100A1"), var.lab=TRUE)
```

```
# an example for the usage of sepID.data and sepID.sep
nci60_mod <- NCI60_4arrays
rownames(nci60_mod$hgu95) <- paste(rownames(nci60_mod$hgu95), "s1", sep="_")
mcoin_mod <- mcia(nci60_mod)
id <- split(rownames(mcoin_mod$mcoa$TCO), mcoin_mod$mcoa$TCO)
sapply(id, function(x) head(x))
```

```
plotVar(mcoin_mod, var=c("S100B", "S100A1"), var.lab=TRUE, sepID.data=1:4, sepID.sep = c("\\.", "\\.", "\\."))
plotVar(mcoin_mod, var=c("S100B", "S100A1"), var.lab=TRUE, sepID.data=4, sepID.sep="_")
plotVar(mcoin_mod, var=c("S100B", "S100A1"), var.lab=TRUE, sepID.data=1:3, sepID.sep="\\.")
```

---

selectVar

*Selecting variables (genes) from result of MCIA or CIA according to co-ordinates*

---

**Description**

The user level function calls `selectVar.mcia` or `selectVar.cia`. Function `cia` or `mcia` projects variables (genes) from different datasets to a 2 dimensional space. This function supplies a method selecting variables (genes) according to the coordinates of variables

**Usage**

```
selectVar(x, axis1 = 1, axis2 = 2, ...)
```

**Arguments**

|       |   |
|-------|---|
| x     | An object of class <code>cia</code> or <code>mcia</code> , the result returned by <code>cia</code> or <code>mcia</code> respectively. |
| axis1 | Integer, the column number for the x-axis. The default is 1.  |
| axis2 | Integer, the column number for the y-axis. The default is 2.  |
| ...   | Other arguments   |

**Value**

Returns a data.frame describing which variables (genes) are presented on which data.frames within the limited region(s).

**Author(s)**

Chen Meng

**See Also**

See Also as [selectVar.mcia](#), [selectVar.cia](#)

**Examples**

```
data(NCI60_4arrays)
mcoin <- mcia(NCI60_4arrays)
selectVar(mcoin, a1.lim=c(2, Inf), a2.lim=c(-Inf, Inf))

# an example for the usage of sepID.data and sepID.sep
nci60_mod <- NCI60_4arrays
rownames(nci60_mod$hgu95) <- paste(rownames(nci60_mod$hgu95), "s1", sep="_")
mcoin_mod <- mcia(nci60_mod)
# without specifying
selectVar(mcoin_mod, a1.lim=c(2, Inf), a2.lim=c(-Inf, Inf))
# specifying the sepID.data and sepID.sep
selectVar(mcoin_mod, a1.lim=c(2, Inf), a2.lim=c(-Inf, Inf), sepID.data=4, sepID.sep="_")
```

---

selectVar.cia

*Selecting variables from result of CIA*

---

**Description**

To select variables in CIA variable space, the function is called by `selectVar`.

**Usage**

```
## S3 method for class 'cia'
selectVar(x, axis1 = 1, axis2 = 2,
  df1.a1.lim = c(-Inf, Inf), df1.a2.lim = c(-Inf, Inf),
  df2.a1.lim = df1.a1.lim, df2.a2.lim = df1.a2.lim,
  sepID.data = NULL, sepID.sep = "_", ...)
```

**Arguments**

|            |  |
|------------|--|
| x          | The result returned by <a href="#">cia</a>   |
| axis1      | Integer, the column number for the x-axis. The default is 1.   |
| axis2      | Integer, the column number for the y-axis. The default is 2.   |
| df1.a1.lim | A vector containing 2 numbers indicating the range of <b>X</b> axis of selected on the <b>1st</b> data.frame. The first value limiting the lower boundary, the second value limiting the upper boundary. |
| df1.a2.lim | The range of <b>Y</b> axis of selected on the <b>1st</b> datasets.   |
| df2.a1.lim | The range of <b>X</b> axis of selected on the <b>2nd</b> dataset.  |
| df2.a2.lim | The range of <b>Y</b> axis of selected on the <b>2nd</b> dataset.  |
| sepID.data | See <a href="#">plotVar.mcia</a>   |
| sepID.sep  | See <a href="#">plotVar.mcia</a>   |
| ...        | Other arguments  |

**Details**

`cia` projecting variables from different datasets to a two dimensional space. This function supplies a method selecting variables according to the co-ordinates of variables

**Value**

Returns a data.frame describing which variables are presented on which data.frame within the limited region(s).

**Author(s)**

Chen Meng

**See Also**

See Also as [selectVar.mcia](#)

---

selectVar.mcia

*Selecting variables from result of MCIA*

---

**Description**

The selection of variables based on co-ordinates of MCIA variable space. The function is called by `selectVar`

**Usage**

```
## S3 method for class 'mcia'
selectVar(x, axis1 = 1, axis2 = 2,
  a1.lim = c(-Inf, Inf), a2.lim = c(-Inf, Inf),
  sepID.data = NULL, sepID.sep = "_", ...)
```

**Arguments**

|            |  |
|------------|--|
| x          | An object of class <code>mci.a</code> , the result returned by <code>mci.a</code> .  |
| axis1      | Integer, the column number for the x-axis. The default is 1.   |
| axis2      | Integer, the column number for the y-axis. The default is 2.   |
| a1.lim     | The limited range of x-axis of selected. It could be either a vector (containing 2 numbers, the first value limiting the lower boundary, the second value limiting the upper boundary) or a list of vectors, each of which contains two number. If it is a list, the length of the list should be the same with number of <code>data.frames</code> in <code>mci.a</code> . |
| a2.lim     | The limited range of y-axis.   |
| sepID.data | See <code>plotVar.mci.a</code>   |
| sepID.sep  | See <code>plotVar.mci.a</code>   |
| ...        | Other arguments  |

**Details**

`mci.a` projecting variables (genes) from different datasets to a lower dimensional space. This function supplies a method selecting variables according to the co-ordinates of variables.

**Value**

Returns a `data.frame` describing which variables are presented on which `data.frames` within the limited region(s).

**Author(s)**

Chen Meng

**See Also**

See Also as `selectVar.cia`, `selectVar`

**Examples**

```
data(NCI60_4arrays)
mcoin <- mci.a(NCI60_4arrays)
selectVar(mcoin, a1.lim=c(1, Inf))
```

---

topVar

*Selecting top weighted variables (genes) from result of MCIA or CIA*


---

**Description**

The user level function calls `topVar.mci.a` or `topVar.cia`. This function provides a method selecting top weighted variables (genes) on an axis (either positive side or negative side or both).

**Usage**

```
topVar(x, axis = 1, end = "both", topN = 5)
```

**Arguments**

|      |  |
|------|--|
| x    | an object of class <code>mcia</code> or <code>cia</code>   |
| axis | an interger to sepecify which axis to check  |
| end  | which end of the axis to check, could be positive, negative or both. Any unambiguous substring can be given. |
| topN | An integer. The number of top weighted variable to return.   |

**Value**

Returns a data.frame contains selected variables.

**Author(s)**

Chen Meng

**Examples**

```
data(NCI60_4arrays)
mcoin <- mcia(NCI60_4arrays)
topVar(mcoin, axis = 1, end = "both", topN = 3)
```

---

topVar.cia

*Selecting top weighted variables (genes) from result of CIA*


---

**Description**

This function provides a method selecting top weighted variables (genes) on an axis (either positive side or negative side or both) from an object of class `cia` (see `made4` package).

**Usage**

```
## S3 method for class 'cia'
topVar(x, axis = 1, end = "both", topN = 5)
```

**Arguments**

|      |                                  |
|------|----------------------------------|
| x    | See <a href="#">plotVar.mcia</a> |
| axis | See <a href="#">plotVar.mcia</a> |
| end  | See <a href="#">plotVar.mcia</a> |
| topN | See <a href="#">plotVar.mcia</a> |

**Value**

See [plotVar.mcia](#)

**Author(s)**

Chen Meng

---

`topVar.mcia`*Selecting top weighted variables (genes) from result of MCIA*

---

**Description**

This function provides a method selecting top weighted variables (genes) on an axis (either positive side or negative side or both) from an object of class `mcia`.

**Usage**

```
## S3 method for class 'mcia'  
topVar(x, axis = 1, end = "both", topN = 5)
```

**Arguments**

|                   |                                  |
|-------------------|----------------------------------|
| <code>x</code>    | See <a href="#">plotVar.mcia</a> |
| <code>axis</code> | See <a href="#">plotVar.mcia</a> |
| <code>end</code>  | See <a href="#">plotVar.mcia</a> |
| <code>topN</code> | See <a href="#">plotVar.mcia</a> |

**Value**

See [plotVar.mcia](#)

**Author(s)**

Chen Meng

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