

# Package ‘MDMeasure’

February 7, 2018

**Title** Mutual Dependence Measures via Energy Statistics  
**Version** 1.0.0  
**Date** 2018-01-30  
**Description** Implementation of mutual dependence measures and mutual independence tests in Jin, Z., and Matteson, D. S. (2017) <<https://arxiv.org/abs/1709.02532>>.  
**Depends** R (>= 3.4.0)  
**Suggests** testthat (>= 2.0.0), energy (>= 1.7-0)  
**License** GPL (>= 2)  
**LazyData** true  
**RoxygenNote** 6.0.1  
**Collate** 'MDMeasure-package.R'  
'mdm.R'  
'mdm\_test.R'

## R topics documented:

|                             |          |
|-----------------------------|----------|
| MDMeasure-package . . . . . | 1        |
| mdm . . . . .               | 2        |
| mdm_test . . . . .          | 3        |
| <b>Index</b>                | <b>5</b> |

---

|                   |   |
|-------------------|---|
| MDMeasure-package | <i>Mutual Dependence Measures via Energy Statistics</i> |
|-------------------|---|

---

## Description

MDMeasure: A package for mutual dependence measures via energy statistics

## Details

The MDMeasure package provides measures of mutual dependence and tests of mutual independence.

### Measuring mutual dependence

The mutual dependence measures include:

- asymmetric measure  $\mathcal{R}_n$  based on distance covariance  $\mathcal{V}_n$
- symmectric measure  $\mathcal{S}_n$  based on distance covariance  $\mathcal{V}_n$
- complete measure  $\mathcal{Q}_n$  based on complete V-statistics
- simplified complete measure  $\mathcal{Q}_n^*$  based on incomplete V-statistics
- asymmetric measure  $\mathcal{J}_n$  based on complete measure  $\mathcal{Q}_n$
- simplified asymmetric measure  $\mathcal{J}_n^*$  based on simplified complete measure  $\mathcal{Q}_n^*$
- symmectric measure  $\mathcal{I}_n$  based on complete measure  $\mathcal{Q}_n$
- simplified symmectric measure  $\mathcal{I}_n^*$  based on simplified complete measure  $\mathcal{Q}_n^*$

### Testing mutual independence

The mutual independence tests based on the mutual dependence measures are implemented as permutation tests.

### Author(s)

Ze Jin <zj58@cornell.edu>, David S. Matteson <matteson@cornell.edu>

---

|     |                                   |
|-----|-----------------------------------|
| mdm | <i>Mutual Dependence Measures</i> |
|-----|-----------------------------------|

---

### Description

mdm measures mutual dependence of all components in  $X$ , where each component contains one variable (univariate) or more variables (multivariate).

### Usage

```
mdm(X, dim_comp = NULL, dist_comp = FALSE, type = "comp_simp")
```

### Arguments

|           |   |
|-----------|---|
| $X$       | A matrix or data frame, where rows represent samples, and columns represent variables.  |
| dim_comp  | The numbers of variables contained by all components in $X$ . If omitted, each component is assumed to contain exactly one variable.  |
| dist_comp | Logical. If TRUE, the distances between all components from all samples in $X$ will be returned.  |
| type      | The type of mutual dependence measures, including <ul style="list-style-type: none"> <li>- asym_dcov: asymmetric measure <math>\mathcal{R}_n</math> based on distance covariance <math>\mathcal{V}_n</math>;</li> <li>- sym_dcov: symmectric measure <math>\mathcal{S}_n</math> based on distance covariance <math>\mathcal{V}_n</math>;</li> <li>- comp: complete measure <math>\mathcal{Q}_n</math> based on complete V-statistics;</li> <li>- comp_simp: simplified complete measure <math>\mathcal{Q}_n^*</math> based on incomplete V-statistics;</li> <li>- asym_comp: asymmetric measure <math>\mathcal{J}_n</math> based on complete measure <math>\mathcal{Q}_n</math>;</li> </ul> |

- asym\_comp\_simp: simplified asymmetric measure  $\mathcal{J}_n^*$  based on simplified complete measure  $\mathcal{Q}_n^*$ ;
- sym\_comp: symmetric measure  $\mathcal{I}_n$  based on complete measure  $\mathcal{Q}_n$ ;
- sym\_comp\_simp: simplified symmetric measure  $\mathcal{I}_n^*$  based on simplified complete measure  $\mathcal{Q}_n^*$ .

## Value

mdm returns a list including the following components:

|      |  |
|------|--|
| stat | The value of mutual dependence measure.                |
| dist | The distances between all components from all samples. |

## References

Jin, Z., and Matteson, D. S. (2017). Generalizing Distance Covariance to Measure and Test Multivariate Mutual Dependence. arXiv preprint arXiv:1709.02532. <https://arxiv.org/abs/1709.02532>.

## Examples

```
# X is a 10 x 3 matrix with 10 samples and 3 variables
X <- matrix(rnorm(10 * 3), 10, 3)

# assume X = (X1, X2) where X1 is 1-dim, X2 is 2-dim
mdm(X, dim_comp = c(1, 2), type = "asym_dcov")

# assume X = (X1, X2) where X1 is 2-dim, X2 is 1-dim
mdm(X, dim_comp = c(2, 1), type = "sym_dcov")

# assume X = (X1, X2, X3) where X1 is 1-dim, X2 is 1-dim, X3 is 1-dim
mdm(X, dim_comp = c(1, 1, 1), type = "comp_simp")
```

---

|          |                                  |
|----------|----------------------------------|
| mdm_test | <i>Mutual Independence Tests</i> |
|----------|----------------------------------|

---

## Description

mdm\_test tests mutual independence of all components in X, where each component contains one variable (univariate) or more variables (multivariate). All tests are implemented as permutation tests.

## Usage

```
mdm_test(X, dim_comp = NULL, num_perm = NULL, type = c("comp_simp"))
```

## Arguments

|                       |  |
|-----------------------|--|
| <code>X</code>        | A matrix or data frame, where rows represent samples, and columns represent variables.   |
| <code>dim_comp</code> | The numbers of variables contained by all components in <code>X</code> . If omitted, each component is assumed to contain exactly one variable.  |
| <code>num_perm</code> | The number of permutation samples drawn to approximate the asymptotic distributions of mutual dependence measures. If omitted, an adaptive permutation size is used.   |
| <code>type</code>     | The type of mutual dependence measures, including <ul style="list-style-type: none"> <li>- <code>asym_dcov</code>: asymmetric measure <math>\mathcal{R}_n</math> based on distance covariance <math>\mathcal{V}_n</math>;</li> <li>- <code>sym_dcov</code>: symmetric measure <math>\mathcal{S}_n</math> based on distance covariance <math>\mathcal{V}_n</math>;</li> <li>- <code>comp</code>: complete measure <math>\mathcal{Q}_n</math> based on complete V-statistics;</li> <li>- <code>comp_simp</code>: simplified complete measure <math>\mathcal{Q}_n^*</math> based on incomplete V-statistics;</li> <li>- <code>asym_comp</code>: asymmetric measure <math>\mathcal{J}_n</math> based on complete measure <math>\mathcal{Q}_n</math>;</li> <li>- <code>asym_comp_simp</code>: simplified asymmetric measure <math>\mathcal{J}_n^*</math> based on simplified complete measure <math>\mathcal{Q}_n^*</math>;</li> <li>- <code>sym_comp</code>: symmetric measure <math>\mathcal{I}_n</math> based on complete measure <math>\mathcal{Q}_n</math>;</li> <li>- <code>sym_comp_simp</code>: simplified symmetric measure <math>\mathcal{I}_n^*</math> based on simplified complete measure <math>\mathcal{Q}_n^*</math>.</li> </ul> |

## Value

`mdm_test` returns a list including the following components:

|                   |  |
|-------------------|--|
| <code>stat</code> | The value of mutual dependence measure.  |
| <code>pval</code> | The p-value of mutual independence test. |

## References

Jin, Z., and Matteson, D. S. (2017). Generalizing Distance Covariance to Measure and Test Multivariate Mutual Dependence. arXiv preprint arXiv:1709.02532. <https://arxiv.org/abs/1709.02532>.

## Examples

```
## Not run:
# X is a 10 x 3 matrix with 10 samples and 3 variables
X <- matrix(rnorm(10 * 3), 10, 3)

# assume X = (X1, X2) where X1 is 1-dim, X2 is 2-dim
mdm_test(X, dim_comp = c(1, 2), type = "asym_dcov")

# assume X = (X1, X2) where X1 is 2-dim, X2 is 1-dim
mdm_test(X, dim_comp = c(2, 1), type = "sym_dcov")

# assume X = (X1, X2, X3) where X1 is 1-dim, X2 is 1-dim, X3 is 1-dim
mdm_test(X, dim_comp = c(1, 1, 1), type = "comp_simp")

## End(Not run)
```

# Index

mdm, [2](#)  
mdm\_test, [3](#)  
MDMeasure (MDMeasure-package), [1](#)  
MDMeasure-package, [1](#)