# Package ‘mvctm’

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**Title** Multivariate Variance Components Tests for Multilevel Data  
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**R topics documented:**

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Description

Permutation tests for variance components for 2-level, 3-level and 4-level data with univariate or multivariate responses.

Details

Package: mvctm
Type: Package
Version: 1.1
Date: 2017-03-08

Author(s)

Denis Larocque
Maintainer: Denis Larocque <denis.larocque@hec.ca>

References


Usage

mvctm(fixed, cluster, data, leveltested, method = "ls", npermut = 1000, weight = "observation", affequiv = TRUE)
mvctm

Arguments

fixed
An object of class "formula" describing the fixed effects part of the model using the variables in the data frame data.

cluster
A vector giving the name of the variables in the data frame data to specify the clustering configuration. The order is important. For 2-level data it is a vector of dimension 1 specifying the level 1 cluster. For 3-level data, it is a vector of dimension 2. The first element specifies the level 1 (outer) cluster and the second one specifies the level 2 (inner) cluster. For 4-level data, it is a vector of dimension 3. The first element specifies the level 1 (outer) cluster, the second one specifies the level 2 (middle) cluster, and the last one specifies the level 3 (inner) cluster.

data
A data frame containing the data.

leveltested
An integer giving the level to be tested. It must be 1 for 2-level data, 1 or 2 for 3-level data, and 1, 2 or 3 for 4-level data. It corresponds to the element in cluster.

method
The scores to be used. The four choices "ls", "mixed", "rank" and "sign" are available. The default is "ls". The choice "mixed" is only available for a univariate response.

npermut
The number of random permutation used to perform the test. The default is 1000.

weight
The weight function to be used. The three choices "pair", "observation" and "cluster" are available. The default is "observation".

affequiv
Whether or not we want to use the affine-equivariant version of the tests. This is only relevant for a multivariate response and method="rank" or "sign". The default is TRUE.

Details

With method="ls", the fixed effects are estimated by ordinary least-squares. Then the test is performed on the residuals from this fit. With method="mixed", the fixed effects are estimated with a linear mixed model. Then the test is performed on the marginal (population) residuals from this fit. With method="rank", a rank-based method is used to estimate the fixed effects. Then the test is performed on the ranks of the residuals from this fit. Finally, with method="sign", a sign-based method is used to estimate the fixed effects. Then the test is performed on the signs of the residuals from this fit. For multivariate data, spatial ranks and signs are used.

With a univariate response, method="sign" is not recommended because the test might be liberal. With, weight="pair", observations in larger clusters at the level leveltested will have more weights. With, weight="cluster", the same weight is given to each cluster at the level leveltested. As a compromise between these two, the default weight="observation" gives an equal weight to each individual observation, with respect to the clusters at level leveltested.

Value

A list with the following two elements:

pvalue
The p-value of the test.

statistic
The value of the test statistic computed on the original data.
Author(s)
Denis Larocque <denis.larocque@hec.ca>

References

Examples

data(toydata)

# Bivariate 2-level model.
# Classroom as the clusters.
# Only an intercept is in the fixed part of the model.
# Test based on 200 permutations
mvctm(fixed=cbind(y1,y2)~1,cluster=c("classroom"),
data=toydata,leveltested=1,npermut=200)

# Same as above but The two covariates are in the fixed part of the model.
# Test based on 1000 permutations (default).
## Not run:
mvctm(fixed=cbind(y1,y2)~x1+x2,cluster=c("classroom"),
data=toydata,leveltested=1)

## End(Not run)

# Same as above but the rank scores are used.
## Not run:
mvctm(fixed=cbind(y1,y2)~x1+x2,cluster=c("classroom"),
data=toydata,leveltested=1, method="rank")

## End(Not run)

# Univariate 4-level model.
# Classrooms, nested within schools, nested within regions.
# The variance component at the region level is tested.
# The fixed effects are estimated with a linear mixed model.
## Not run:
mvctm(fixed=y1~x1+x2,cluster=c("region","school","classroom"),
data=toydata,leveltested=1,method="mixed")

## End(Not run)

# Same as above but the variance component at the school level is tested.
## Not run:
mvctm(fixed=y1~x1+x2,cluster=c("region","school","classroom"),
data=toydata,leveltested=2,method="mixed")

## End(Not run)
```
permcluster

# Same as above but the variance component at the classroom level is tested.
## Not run:
mvctm(fixed=y1~x1+x2,cluster=c("region","school","classroom"),
data=toydata,leveltested=3,method="mixed")

## End(Not run)

# Univariate 3-level model.
# The variance component at the classroom level is tested.
# The fixed effects are removed with an M-estimator with the rlm function
# in the MASS package.
# Then the residuals from this fit are used to perform the test.
# The ~0 in the formula tells mvctm to use mresid directly to perform
# the test without any centering or transformation.
## Not run:
library("MASS")
toydata[,"mresid"]=rlm(y1~x1+x2,data=toydata)$residuals
mvctm(fixed=mresid~0,cluster=c("school","classroom"),
data=toydata,leveltested=2)

## End(Not run)
```

---

**permcluster**  
*Generates a Permutated Data Set*

**Description**

This function generates a permuted data set that can be used to perform a permutation test for a variance component for 2-level, 3-level or 4-level data.

**Usage**

`permcluster(cluster, data, leveltested)`

**Arguments**

- **cluster**  
  A vector giving the name of the variables in the data frame `data` to specify the clustering configuration. The order is important. For 2-level data it is a vector of dimension 1 specifying the level 1 cluster. For 3-level data, it is a vector of dimension 2. The first element specifies the level 1 (outer) cluster and the second one specifies the level 2 (inner) cluster. For 4-level data, it is a vector of dimension 3. The first element specifies the level 1 (outer) cluster, the second one specifies the level 2 (middle) cluster, and the last one specifies the level 3 (inner) cluster.

- **data**  
  A data frame containing the data.

- **leveltested**  
  An integer giving the level to be tested. It must be 1 for 2-level data, 1 or 2 for 3-level data, and 1, 2 or 3 for 4-level data. It corresponds to the element in `cluster`. 
Details

This is a utility function that allows to perform a permutation test with another test statistic than the one in the function `mvctm`.

Value

A data frame that contains the original variables plus 1, 2 or 3 new columns. For 2-level data, a single new column called `clusperm1` contains the permuted indices for the level 1 cluster. For 3-level data, two new columns called `clusperm1` and `clusperm2` contain the permuted indices for the level 1 and level 2 clusters, respectively. For 4-level data, three new columns called `clusperm1`, `clusperm2` and `clusperm3` contain the permuted indices for the level 1, level 2, and level 3 clusters, respectively.

Author(s)

Denis Larocque <denis.larocque@hec.ca>

References


Examples

data(toydata)
# generates a permuted data set with 2-level data
permcluster(cluster=c("classroom"),data=toydata,leveltested=1)
# generates a permuted data set with 4-level data to test for level 2
permcluster(cluster=c("region","school","classroom"),
data=toydata,leveltested=2)
# performing a permutation test with another
# test statistic might look like this

## Not run:
pval=0
# compute the statistic with the original data. Call in stato.
for (i in 1:npermut)
{
pdata=permcluster(cluster=c("classroom"),data=toydata,leveltested=1)
# compute the statistic with pdata using the new column
# clusperm1 instead of classroom as the cluster index.
# call it statp.
pval=pval+(statp>stato)
}
pval/npermut
toydata

## Artificial 4-level data set

**Description**

A 4-level data set with two responses and two covariates to illustrate the package mvctm. The classroom is nested within the school which is nested within the region.

**Usage**

```r
data(toydata)
```

**Format**

A data frame with 150 observations on the following 7 variables.

- **y1** The first response
- **y2** The second response
- **x1** The first covariate
- **x2** The second covariate
- **region** The level 1 cluster (outer)
- **school** The level 2 cluster (middle)
- **classroom** The level 3 cluster (inner)

**Examples**

```r
data(toydata)
```
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