QAD-Package

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1 Introduction

The *"Quantification of Asymmetric Dependence"* package introduces a copula-based dependency measure capable of detecting and depicting asymmetry.

It does so, by constructing the empirical copula from a given bivariate sample and aggregating it to the smooth empirical checkerboard copula, which is used as a strongly consistent estimate for the dependency measure used.

2 qad

2.1 Description

Quantifies the (asymmetric) dependence structure between two random variables X and Y.

2.2 Arguments

qad(x,. . .)

- x: either a data.frame containing columns of observations of two random variables or a vector containing the observations of one.

- y: if x is not a data.frame of two columns, a vector containing the observations of the second random variable.

- *resolution*: an integer indicating the number of strips for the checkerboard aggregation. Default = NULL uses the optimal resolution.

- *permutation*: a logical indicating whether a permutated p-value is computed.

- *nperm*: an integer indicating the number of permutation runs.

2.3 Value

qad returns an object of class qad containing the following components:

- *data*: a data.frame containing the input data.

- *results*: a data.frame containing the results of the dependence measures.

- *mass_matrix*: a matrix containing the mass distribution of the empirical checkerboard copula.

- *resolution*: an integer containing the used resolution of the checkerboard aggregation.

2.4 Examples

```
## Warning:  package 'qad' was built under R version 3.5.3
```

```
n = 200
x = runif(n,-2,4)
y = sin(x^2)
df = data.frame(x,y)
model = qad(df, print = FALSE, permutation = TRUE)
model$results
```

```
##                         coef p.values
## 1        q(x1,x2) 0.7090350        0
## 2        q(x2,x1) 0.4169353        0
## 3 mean.dependence 0.5629851        0
## 4 asymmetry       0.2920997        0
```

3 pairwise.qad

Computes the function qad() for each pair of columns in the given data frame and returns a list of corresponding qad objects.

4 heatmap.qad

The pairwise computated dependency measure as output from the pairwise.qad() function, are illustrated by a heatmap.

4.1 Arguments

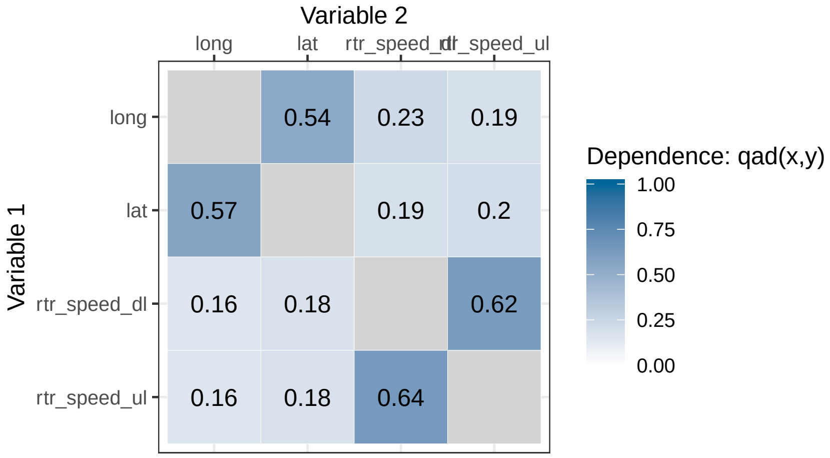
- *pw_qad*: output of the function pairwise.qad().
- *select*: a character indicating which dependence value is plotted. Options are c(”dependence”,”mean.dependence”, ”asymmetry”).
- *fontsize*: a numeric specifying the font size of the values.
- *significance*: a logical indicating whether significant values - with respect to the permutatedp.values - are marked with a star.
- *sign.level*: numeric value indicating the significance level.
- *scale*: character indicating whether the heatmap uses a relative or absolute scale. Op-tions are ”rel” or ”abs” (default).

4.2 Example

```
  load(url("http://www.trutschnig.net/RTR.RData"))
  df = RTR[sample(nrow(RTR),1000),
           c('long','lat','rtr_speed_dl','rtr_speed_ul')]
  model = pairwise.qad(df)

## [1] "Process..."
## [1] "Process: 1 / 4"
## [1] "Process: 2 / 4"
## [1] "Process: 3 / 4"
```

```
heatmap.qad(model)
```



5 cci

An approximated confidence interval for the dependence measure qad(x,y) for independent random variables . cci() can thus be used to test for independence

5.1 Arguments

- *n*: and integer indicating the sample size
- *alternative*: character string, whether a "one.sided" (default), or "two.sided" confidence intervall is constructed.

5.2 Example

```
c = cci(n, alternative = "one.sided")

x = runif(n,-2,4)
y = sin(x^2)
df = data.frame(x,y)
model = qad(df,print=FALSE)

if(coef(model, select = 'q(x1,x2)') %in% c){
 print('Accept H0')
}else{
 print('Reject H0')
}

## [1] "Reject H0"
```