

# Package ‘crossmatch’

February 19, 2015

**Type** Package

**Title** The Cross-match Test

**Version** 1.3-1

**Date** 2012-06-16

**Author** Ruth Heller <ruheller@post.tau.ac.il>, Dylan Small  
<dsmall@wharton.upenn.edu>, Paul Rosenbaum  
<rosenbap@wharton.upenn.edu>

**Maintainer** Ruth Heller <ruheller@gmail.com>

**Description** This package performs a test for comparing two multivariate distributions by using the distance between observations. The input is a distance matrix and the labels of the two groups to be compared, the output is the number of cross-matches and a p-value.

**Depends** survival,nbpMatching

**Suggests** MASS

**License** GPL-2

**LazyLoad** yes

**Repository** CRAN

**Date/Publication** 2012-06-17 00:13:00

**NeedsCompilation** no

## R topics documented:

crossmatch-package . . . . .	2
crossmatchdist . . . . .	3
crossmatchtest . . . . .	4

<b>Index</b>	<b>6</b>
--------------	----------

---

crossmatch-package      *The Cross-Match Test For Comparing Two Multivariate Distributions.*

---

## Description

The cross-match test is an exact, distribution free test of equality of 2 high dimensional multivariate distributions.

## Details

Package: crossmatch  
 Type: Package  
 Version: 1.3-1  
 Date: 2012-06-16  
 License: GPL-2  
 LazyLoad: yes

For the cross-match test, use the function [crossmatchtest](#).

## Author(s)

Ruth Heller, Paul Rosenbaum, Dylan Small. Maintainer: Ruth Heller <ruheller@post.tau.ac.il>

## References

Rosenbaum, P.R. (2005), An exact distribution-free test comparing two multivariate distributions based on adjacency, *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **67**, 4, 515-530.

## Examples

```
## The example in Section 2 of the article (see References)

#The data consists of 2 outcomes measured on 9 treated cases and 9 controls:
dat <- rbind(c(0.47,0.39,0.47,0.78,1,1,0.54,1,0.38,1,0.27,0.63,0.22,0,-1,-0.42,-1,-1),
            c(0.03,0.11,0.16,-0.1,-0.05,0.16,0.12,0.4,0.04,0.71,0.01,0.21,-0.18,-0.08
            , -0.35,0.26,-0.6
z <- c(rep(0,9),rep(1,9))
X <- t(dat)

## Rank based Mahalanobis distance between each pair:
X <- as.matrix(X)
n <- dim(X)[1]
k <- dim(X)[2]
for (j in 1:k) X[,j] <- rank(X[,j])
cv <- cov(X)
vuntied <- var(1:n)
```

```

rat <- sqrt(vuntied/diag(cv))
cv <- diag(rat)%*%cv%*%diag(rat)
out <- matrix(NA,n,n)

library(MASS)

icov <- ginv(cv)
for (i in 1:n) out[i,] <- mahalnobis(X,X[i,],icov,inverted=TRUE)

dis <- out

## The cross-match test:

crossmatchtest(z,dis)

```

---

crossmatchdist	<i>The Exact Null Distribution Of The Cross-match Statistic Under The Null</i>
----------------	--

---

## Description

The exact null distribution of the number of crossmatches for  $\text{bigN} \geq 4$  cases,  $n \geq 2$  from one type and  $N-n \geq 2$  from another type.

## Usage

```
crossmatchdist(bigN, n)
```

## Arguments

bigN	The total number of observations
n	The number of cases from one type

## Details

bigN is even. Let  $a_1$  be the number of cross-matches pairs. Then  $a_2 = (n - a_1) / 2$  and  $a_0 = \text{bigN} / 2 - (n + a_1) / 2$  are the number of pairs both of one type and the other type respectively.

## Value

dist	A matrix with rows $a_0$ , $a_1$ , $a_2$ , $\Pr(A_1 = a_1)$ and $\Pr(A_1 \leq a_1)$ .
------	---

## Author(s)

Ruth Heller

## References

Rosenbaum, P.R. (2005), An exact distribution-free test comparing two multivariate distributions based on adjacency, *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **67**, 4, 515-530.

## Examples

```
crossmatchdist(18,9)
```

---

crossmatchtest	<i>The Cross-Match Test</i>
----------------	-----------------------------

---

## Description

A test for comparing two multivariate distributions by using the distance between the observations.

## Usage

```
crossmatchtest(z, D)
```

## Arguments

z	A binary vector corresponding to observations class labels.
D	A distance matrix of dimensions NxN, where N is the total number of observations.

## Details

Observations are divided into pairs to minimize the total distance within pairs, using a polynomial time algorithm made available in R by Lu, B., Greevy, R., Xu, X., and Beck, C in the R package "nbpMatching". The cross-match test takes as the test statistic the number of times a subject from one group was paired with a subject from another group, rejecting the hypothesis of equal distribution for small values of the statistic; see Rosenbaum (2005) for details.

## Value

A list with the following

a1	The number of cross-matches
Ea1	The expected number of cross-matches under the null
Va1	The variance of number of cross-matches under the null
dev	The observed difference from expectation under null in SE units
pval	The p-value based on exact null distribution (NA for datasets with 340 observations or more)
approxpval	The approximate p-value based on normal approximation

**Author(s)**

Ruth Heller

**References**

Rosenbaum, P.R. (2005), An exact distribution-free test comparing two multivariate distributions based on adjacency, *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **67**, 4, 515-530.

**Examples**

```
## The example in Section 2 of the article (see References)

#The data consists of 2 outcomes measured on 9 treated cases and 9 controls:
dat <- rbind(c(0.47,0.39,0.47,0.78,1,1,0.54,1,0.38,1,0.27,0.63,0.22,0,-1,-0.42,-1,-1),
            c(0.03,0.11,0.16,-0.1,-0.05,0.16,0.12,0.4,0.04,0.71,0.01,0.21,-0.18,-0.08
            , -0.35,0.26,-0.6

z <- c(rep(0,9),rep(1,9))
X <- t(dat)

## Rank based Mahalanobis distance between each pair:
X <- as.matrix(X)
n <- dim(X)[1]
k <- dim(X)[2]
for (j in 1:k) X[,j] <- rank(X[,j])
cv <- cov(X)
vuntied <- var(1:n)
rat <- sqrt(vuntied/diag(cv))
cv <- diag(rat)%*%cv%*%diag(rat)
out <- matrix(NA,n,n)

library(MASS)

icov <- ginv(cv)
for (i in 1:n) out[i,] <- mahalanobis(X,X[i,],icov,inverted=TRUE)

dis <- out

## The cross-match test:

crossmatchtest(z,dis)
```

# Index

\*Topic **multivariate**

crossmatch-package, 2

\*Topic **nonparametric**

crossmatch-package, 2

crossmatch (crossmatch-package), 2

crossmatch-package, 2

crossmatchdist, 3

crossmatchtest, 2, 4