Package ‘ibd’

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Title INCOMPLETE BLOCK DESIGNS
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Description This package contains several utility functions related to incomplete block designs. The package contains function to generate efficient incomplete block designs with given numbers of treatments, blocks and block size. The package also contains function to generate an incomplete block design with specified concurrence matrix. There are functions to generate balanced treatment incomplete block designs and incomplete block designs for test versus control treatments comparisons with specified concurrence matrix. Package also allows performing analysis of variance of data and computing least square means of factors from experiments using a connected incomplete block design. Tests of hypothesis of treatment contrasts in incomplete block design set up is supported.
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aov.ibd

Analysis of variance, least square means and contrast analysis of data from a block design

Description

This function performs intrablock analysis of variance of data from experiments using a block design. It also computes least square means of the factor variables (e.g. treatments) and optionally estimates and tests the contrasts of factor variables (e.g treatments).

Usage

aov.ibd(formula, specs, data, contrast, joint=FALSE, details=FALSE, sort=TRUE, by=NULL, alpha=0.05, Letters = "ABCDEFGHIJ",...)

Arguments

formula  A formula specifying the model of the form response~treatment+block or response~block+treatment. Make sure the treatment and blocks are factor variables.
specs  A character vector specifying the names of the factors over which Least square means are desired
data  A data frame in which the variables specified in the formula will be found. If missing, the variables are searched for in the standard way.
contrast  A matrix whose rows are contrasts of factors (e.g. treatments)
joint  If contrast argument has more than one row, then whether a joint test of the contrasts will be performed. Default is FALSE. If joint=TRUE, a check is performed whether the contrasts are pairwise orthogonal or not and then if orthogonal, joint test is performed.
details  Logical, if details=TRUE then all objects including lm object from lm(), lsmeans object from lsmeans() are returned. Default is FALSE.
sort  Logical value determining whether the least square means are sorted before the comparisons are produced. Default is TRUE.
by  Character value giving the name or names of variables by which separate families of comparisons are tested. If NULL, all means are compared.
A_eff

alpha Numeric value giving the significance level for the comparisons

Letters Characters to be used for compact letter display of groups of factor variables over which least square means are computed. Default is english alphabet capital letters "ABCDEFGHIJ"

... Not used

details

The function makes use of lm() function in R and Anova() function in car package with specification of Type III sum of squares and lsmeans(), cld(), contrast() functions in lsmeans() package and combines the results in a single place.

description

This function computes lower bound to A-efficiency of an incomplete block design. Incidence matrix of the design is to be supplied as input to the function.

Usage

A_eff(N)

Arguments

N incidence matrix
**A_eff_tc**

**Value**

\[ A_{eff} \quad \text{A-efficiency} \]

**Author(s)**

B N Mandal <mandal.stat@gmail.com>

**Examples**

```r
N=matrix(c(1,0,0,0,1,0,1,0,1,0,1,0,1,0,1,1,0,0,0,0,0,0,1,1,0,0,0,1,1,0,0,0,1,0,0,1,0,1,0,1,1,0,0),nrow=7,byrow=TRUE)
A_eff(N)
```

```
A_eff_tc          A-efficiency of incomplete block design for test vs control(s) comparisons
```

**Description**

This function computes lower bound to A-efficiency of incomplete block design for test vs control(s) comparisons

**Usage**

```r
A_eff_tc(N,v1,v2,b,k)
```

**Arguments**

- `N`: incidence matrix
- `v1`: number of test treatments
- `v2`: number of control treatments
- `b`: number of blocks
- `k`: block size

**Value**

\[ A_{eff} \quad \text{A-efficiency of the design} \]

**Author(s)**

B N Mandal <mandal.stat@gmail.com>

**Examples**

```r
N=matrix(c(1,1,0,0,0,0,0,1,1,0,1,1,0,1,1,0,1,0,1,1,0,0,1,1,1,0,1,0,1,1,1,0,0),nrow=5,byrow=TRUE)
A_eff(N)
```
Description

This function generates a balanced incomplete block design with given number of treatments(v), number of blocks(b), number of replications (r), block size(k) and number of concurrences (lambda).

Usage

```r
bibd(v, b, r, k, lambda, ntrial, pbar = FALSE)
```

Arguments

- v: number of treatments
- b: number of blocks
- r: number of replications
- k: block size
- lambda: number of concurrences
- ntrial: number of trials
- pbar: logical value indicating whether progress bar will be displayed or not. Default is FALSE

Value

- v: number of treatments
- b: number of blocks
- r: number of replications
- k: block size
- lambda: number of concurrences
- design: block contents in a b by k matrix
- N: incidence matrix of the generated design
- NNP: concurrence matrix of the generated design
- Aeff: Lower bound to the A-efficiency of the generated design
- Deff: Lower bound to the D-efficiency of the generated design

Author(s)

B N Mandal <mandal.stat@gmail.com>
References

Examples

\[
\text{bibd}(7, 7, 3, 3, 1, \text{pbar}=\text{FALSE})
\]

Description
This function generates balanced treatment incomplete block design for specified parameters.

Usage

\[
\text{btib}(v, b, r, r_0, k, \lambda, \lambda_0, n_{\text{trial}}=5, \text{pbar}=\text{FALSE})
\]

Arguments

\begin{itemize}
\item \texttt{v} \hspace{1cm} \text{number of test treatments}
\item \texttt{b} \hspace{1cm} \text{number of blocks}
\item \texttt{r} \hspace{1cm} \text{number of replications of test treatments}
\item \texttt{r_0} \hspace{1cm} \text{number of replications of control treatment}
\item \texttt{k} \hspace{1cm} \text{block size}
\item \texttt{\lambda} \hspace{1cm} \text{number of concurrences among test treatments}
\item \texttt{\lambda_0} \hspace{1cm} \text{number of concurrences between test treatments and control treatment}
\item \texttt{n_{\text{trial}}} \hspace{1cm} \text{number of trials. Default is 5.}
\item \texttt{\text{pbar}} \hspace{1cm} \text{Logical value indicating whether progress bar will be displayed or not. Default is FALSE.}
\end{itemize}

Value

\begin{itemize}
\item \texttt{v} \hspace{1cm} \text{number of test treatments}
\item \texttt{b} \hspace{1cm} \text{number of blocks}
\item \texttt{r} \hspace{1cm} \text{number of replications of test treatments}
\item \texttt{r_0} \hspace{1cm} \text{number of replications of control treatment}
\item \texttt{k} \hspace{1cm} \text{block size}
\end{itemize}
balanced treatment incomplete block designs

Description

This function generates balanced treatment incomplete block design for specified parameters by searching all possible combinations.

Usage

btib1(v,b,r,r0,k,lambda,lambda0)

Arguments

v number of test treatments
b number of blocks
r number of replications of test treatments
r0 number of replications of control treatment
k block size
lambda number of concurrences among test treatments
lambda0 number of concurrences between test treatments and control treatment
Information matrix from given incidence matrix of a block design

This function gives the information matrix from a given incidence matrix of a block design

Usage

Cmatrix(N)

Arguments

N incidence matrix
**design_to_N**

**Value**

Cmatrix v by v information matrix where v is number of treatments

**Author(s)**

B N Mandal <mandal.stat@gmail.com>

**Examples**

```
N=matrix(c(1,0,0,0,0,1,0,1,0,0,0,1,0,0,0,1,0,0,0,1,0,1,0,1,0,0,1,0,1,0,0,0,0,1,0,0,0,1,0,1,0,0,1,0,0,1,0),nrow=7,byrow=TRUE)
Cmatrix(N)
```

```
design_to_N  block design to incidence matrix
```

**Description**

This function generates treatment by block incidence matrix from a given block design

**Usage**

```
design_to_N(design)
```

**Arguments**

```
design          design
```

**Value**

```
N A treatment by block incidence matrix of order v by b with elements as 0 and 1 where v is number of treatments and b is number of blocks
```

**Author(s)**

B N Mandal <mandal.stat@gmail.com>

**Examples**

```
d=matrix(c(1,4,6,5,6,7,3,4,5,2,4,7,1,3,7,2,3,6,1,2,5),nrow=7,byrow=TRUE)
design_to_N(d)
```
D_eff

D-efficiency of a binary incomplete block design

Description
This function computes D-efficiency of a binary incomplete block design. Incidence matrix of the design is to be supplied as input to the function.

Usage
D_eff(N)

Arguments
N incidence matrix

Value
Deff D-efficiency

Author(s)
B N Mandal <mandal.stat@gmail.com>

Examples
N=matrix(c(1,0,0,0,1,0,1,0,0,0,1,0,1,0,0,1,0,1,0,0,1,0,1,0,0,0,0,1,0,1,0,0,0,1,0,1,0,0,0,0,1,0,0,0,0,1,0,0
,1,0,1,0,0),nrow=7,byrow=TRUE)
D_eff(N)

ibd

Incomplete block design for given v,b and k and optionally, with a specified concurrence matrix

Description
This function generates an efficient incomplete block design with given number of treatments(v), number of blocks(b) and block size(k) and optionally with a specified concurrence matrix(NNP).

Usage
ibd(v,b,k,NNP,ntrial,pbar=FALSE)
Arguments

- v:
  number of treatments
- b:
  number of blocks
- k:
  block size
- NNPo:
  optionally, desired concurrence matrix. If not specified, a nearly balanced concurrence matrix is obtained automatically.
- ntrial:
  number of trials
- pbar:
  progress bar

Value

- v:
  number of treatments
- b:
  number of blocks
- k:
  block size
- NNP:
  specified concurrence matrix
- N:
  incidence matrix of the generated design
- design:
  block contents in a b by k matrix
- conc.mat:
  concurrence matrix of the generated design
- A.efficiency:
  A-efficiency of the generated design
- D.efficiency:
  D-efficiency of the generated design
- time.taken:
  time taken to generate the design

Author(s)

B N Mandal <mandal.stat@gmail.com>

References


Examples

v=9
b=12
k=3
ibd(v, b, k, pbar=FALSE)
ibddata  
Data from an experiment using incomplete block design

Description
Data from an experiment using incomplete block design

Usage

data("ibddata")

Format
A data frame with 36 observations on the following 3 variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>trt</td>
<td>Treatments</td>
</tr>
<tr>
<td>blk</td>
<td>Blocks</td>
</tr>
<tr>
<td>y</td>
<td>The response variable</td>
</tr>
</tbody>
</table>

Details
The experiment used a balanced incomplete block design.

References

Examples

data(ibddata)

ibdtvc  
incomplete block design for test vs control(s) comparisons

Description
This function generates incomplete block design for test vs control(s) comparisons with specified parameters and concurrence matrix.

Usage

ibdtvc(v1,v2,b,k,NNPo,ntrial=5,pbar=FALSE)
Arguments

\( v_1 \) number of test treatments
\( v_2 \) number of control treatments
\( b \) number of blocks
\( k \) block size
\( \text{NNPo} \) desired concurrence matrix
\( \text{ntrial} \) number of trials, default is 5
\( \text{pbar} \) Logical value indicating whether progress bar will be displayed. Default is FALSE.

Value

\( v_1=v_1,v_2=v_2,b=b,k=k,\text{design}=\text{design},N=N,\text{NNP}=\text{NNP},\text{Aeff}=\text{Aeff} \)

\( v_1 \) number of test treatments
\( v_2 \) number of control treatments
\( b \) number of blocks
\( k \) block size
\( \text{design} \) generated block design
\( N \) incidence matrix of the generated block design
\( \text{NNP} \) concurrence matrix of the generated design
\( \text{Aeff} \) A-efficiency of the generated design

Author(s)

B N Mandal <mandal.stat@gmail.com>

References

Mandal, BN, Gupta, VK and Parsad, R. (2013). Binary Incomplete Block Designs with a Specified Concurrence Matrix through Integer Programming, to be submitted for publication

Examples

\( \text{NNPo}=\text{matrix}(c(7,3,3,3,3,3,3,7,3,3,3,3,3,7,3,3,3,3,3,3,3,3,3,7,3,3,3,3,3,3,3,3,3,7,3,3,3,3,3,3,3,3,9,9,3,3,3,3,3,9,9),\text{nrow}=8,\text{byrow}=\text{TRUE}) \)
\( \text{ibdtvc}(6,2,15,4,\text{NNPo}) \)
is.connected

Description
This function checks whether an incomplete block design is connected or not. Incidence matrix of the design is to be supplied as input to the function. If the design is connected, it returns a value of 1 else it returns 0.

Usage
is.connected(N)

Arguments
N incidence matrix

Value
connected Connectedness

Author(s)
B N Mandal <mandal.stat@gmail.com>

Examples
n=matrix(c(1,0,0,0,1,0,1,0,0,1,0,1,0,1,0,1,0,0,1,0,1,0,1,0,0,0,0,1,0,1,1,0,0,1,0,1,0,1,0,0,0,1,0,1,1,0,0,1,0,1,0,1,1,0, 0,0,1,0,0,1,0,1,0,1,0,0,0,0,1,0,1,0,1,0,0,0,1,0,1,1,0,0,1,0,1,0,1,0,1,0,0,0,1,0,1,1,0,0,1,0,1,0,1,0,0,0,0,1,0,1,0,1,0, 0,0,1,0,0,1,0,1,0,1,0,0,0,0,1,0,1,0,1,0,0,0,1,0,1,1,0,0,1,0,1,0,1,0,0,0,1,0,1,1,0,0,1,0,1,0,1,0,0,0,0,1,0,1,0,1,0,0,0,0,1,0,1,0,1,0, 0,0,1,0,0,1,0,1,0,1,0,0,0,0,1,0,1,0,1,0,0,0,1,0,1,1,0,0,1,0,1,0,1,0,0,0,1,0,1,1,0,0,1,0,1,0,1,0,0,0,0,1,0,1,0,1,0,0,0,0,1,0,1,0,1,0,0,0),nrow=7,byrow=TRUE)
is.connected(N)

is.equir

Description
This function checks whether an incomplete block design is equi-replicated or not. Incidence matrix of the design is to be supplied as input to the function. If the design is equi-replicated, it returns a value of 1 else it returns 0.

Usage
is.equir(N)

Arguments
N incidence matrix
**Value**

orthogonal

**Author(s)**

B N Mandal <mandal.stat@gmail.com>

**Examples**

```r
N = matrix(c(1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0), nrow = 7, byrow = TRUE)
is.orthogonal(N)
```

---

**Description**

This function checks whether an incomplete block design is orthogonal or not. Incidence matrix of the design is to be supplied as input to the function. If the design is orthogonal, it returns a value of 1 else it returns 0.

**Usage**

```r
is.orthogonal(N)
```

**Arguments**

- `N`: incidence matrix

**Value**

orthogonal

**Author(s)**

B N Mandal <mandal.stat@gmail.com>

**Examples**

```r
N = matrix(c(1, 0, 0, 0, 1, 1, 0, 0, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 1, 1, 0, 0, 0, 1, 0, 1, 0, 0, 0, 0, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0), nrow = 7, byrow = TRUE)
is.orthogonal(N)
```
is.proper

**proper binary incomplete block design**

**Description**

This function checks whether an incomplete block design is proper or not. Incidence matrix of the design is to be supplied as input to the function. If the design is proper, it returns a value of 1 else it returns 0.

**Usage**

```r
is.proper(N)
```

**Arguments**

- `N` incidence matrix

**Value**

- `proper` proper

**Author(s)**

B N Mandal <mandal.stat@gmail.com>

**Examples**

```r
N=matrix(c(1,0,0,0,1,1,0,0,1,1,0,0,1,1,0,0,1,0,1,0,1,0,1,0,0,0,1,1,0,0,0,1,1,1,0,0,0,1,0,0,1,0,1,0,1,0,0,0,1,1,0,0,1,1,0,0,1,0,1,0,1,0,1,0,0,0,1,1,0,0,1,1,0,0,1,0),nrow=7,byrow=TRUE)
is.proper(N)
```

is.vb

**Variance balancedness of a binary incomplete block design**

**Description**

This function checks whether an incomplete block design is variance balanced or not. Incidence matrix of the design is to be supplied as input to the function. If the design is variance balanced, it returns a value of 1 else it returns 0.

**Usage**

```r
is.vb(N)
```

**Arguments**

- `N` incidence matrix
Value

\( vb \) variance balanced

Author(s)

B N Mandal <mandal.stat@gmail.com>

Examples

\[
N = \text{matrix}(c(1, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, \\
1, 0, 1, 0, 0, 1, 1, 0, 0, 0), \text{nrow}=7, \text{byrow}=\text{TRUE})
\]

\[
is \vb(N)
\]

\[
\begin{array}{l}
\text{N_to_design} \\
\text{incidence matrix from given block design}
\end{array}
\]

Description

This function generates the block contents from a given incidence matrix

Usage

\[
\text{N_to_design}(N)
\]

Arguments

\( N \) incidence matrix

Value

\( \text{design} \) A matrix with number of rows equal to number of blocks and number of columns equal to block size. Constant block size is assumed. Treatments are numbered as 1, 2, ..., \( v \)

Author(s)

B N Mandal <mandal.stat@gmail.com>

Examples

\[
N = \text{matrix}(c(1, 0, 0, 0, 1, 0, 0, 1, 0, 1, 0, 1, 0, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 1, 1, 0, \\
1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 0, 0), \text{nrow}=7, \text{byrow}=\text{TRUE})
\]

\[
\text{N_to_design}(N)
\]
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