Package ‘ibd’

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Title INCOMPLETE BLOCK DESIGNS

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Depends R (>= 2.15.1), lpSolve, MASS

Description This package contains several utility functions related to incomplete block designs. The package also 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 from experiments using a connected incomplete block design.

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NeedsCompilation no

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Analysis of variance of data from a block design

Description

This function performs analysis of variance of data from experiments using a block design. Data should be specified with 3 columns, first column should have treatments, second column should have blocks and third column should have response variable. Treatments and blocks should be numbered as 1, 2,... There is also option for estimating and testing a treatment contrast.

Usage

aov.ibd(data, contrast)

Arguments

data data
contrast treatment contrast

Value

aov.table ANOVA Table
contrast.table Estimate and test of significance of the contrast

Author(s)

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

References

Examples

```r
trt=c(1,2,3,7,9,8,6,4,5,1,7,4,8,5,2,3,6,9,1,8,6,4,2,9,3,5,7,1,9,5,2,6,7,8,3,4)
blk=c(1,1,2,2,3,3,4,4,5,5,5,5,5,6,6,6,6,7,7,7,7,7,7,7,7,7,8,8,8,8,9,9,9,9,10,10,10,10,11,11,11,11,12,12,12)
data=data.frame(trt,blk,y)
contrast=c(1,-1,0,0,0,0,0,0)
aov.ibd(data,contrast)
```

---

**A_eff**

A-efficiency of a binary incomplete block design

**Description**

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

**Usage**

```r
A_eff(N)
```

**Arguments**

- **N** incidence matrix

**Value**

- **Aeff** A-efficiency

**Author(s)**

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

**Examples**

```r
N=matrix(c(1,0,0,0,1,0,0,
0,0,1,0,1,1,
0,0,1,0,1,1,0,
1,0,1,1,0,0,0,
0,1,1,0,0,0,1,
1,1,0,0,0,1,0,
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 A-efficiency of incomplete block design for test vs control(s) comparisons

Usage

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} A-efficiency of the design

Author(s)

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

Examples

N=matrix(c(1,1,0,0,0,0,0,1,1,1,0,1,0,1,0,1,1,1,1,1,0,1,0,1,0,1,1,1,1,1,0,1,0,1,0,1,1,1,1,1),nrow=5,byrow=TRUE)
A\_eff\_tc(N,4,1,5,3)
btib

balanced treatment incomplete block design

Description

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

Usage

btib(v, b, r, r0, k, lambda, lambda0, ntrial)

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
ntrial number of trials

Value

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
design generated block design
N  incidence matrix of the generated block design
NNP concurrence matrix of the generated design
Aeff A-efficiency of the generated design

Author(s)

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

Examples

btib(4, 6, 3, 6, 3, 1, 3, 10)
Information matrix from given incidence matrix of a block design

Description

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

Usage

\[ C(N) \]

Arguments

- **N**: Incidence matrix

Value

- **C**: \( v \) by \( v \) information matrix where \( v \) is the number of treatments.

Author(s)

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

Examples

```r
N <- matrix(c(1, 0, 0, 0, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 0, 0, 0, 1, 1, 0, 0, 0), nrow = 7, byrow = TRUE)
C(N)
```

block design to incidence matrix

Description

This function generates incidence matrix from a given block design.

Usage

\[ \text{design_to_N}(\text{design}) \]
D_eff

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

\[ N = \begin{bmatrix} 1 & 0 & 0 & 1 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 & 1 & 1 \\ 0 & 1 & 0 & 1 & 1 & 0 & 1 \\ 1 & 0 & 1 & 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 1 & 0 & 1 & 1 & 0 & 0 \end{bmatrix}, \text{nrow}=7, \text{byrow}=\text{TRUE} \]

\( D_{\text{eff}}(N) \)

\textit{ibd}  \hspace{1cm} \textit{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\((\text{NNP})\).

Usage

\texttt{ibd(v,b,k,ntrial,\text{NNP},pbar=FALSE)}

Arguments

\texttt{v}  \hspace{1cm} \text{number of treatments} \\
\texttt{b}  \hspace{1cm} \text{number of blocks} \\
\texttt{k}  \hspace{1cm} \text{block size} \\
\texttt{ntrial}  \hspace{1cm} \text{number of trials} \\
\texttt{\text{NNP}}  \hspace{1cm} \text{desired concurrence matrix} \\
\texttt{pbar}  \hspace{1cm} \text{progress bar}

Value

\texttt{v}  \hspace{1cm} \text{number of treatments} \\
\texttt{b}  \hspace{1cm} \text{number of blocks} \\
\texttt{k}  \hspace{1cm} \text{block size} \\
\texttt{\text{NNP}}  \hspace{1cm} \text{specified concurrence matrix} \\
\texttt{N}  \hspace{1cm} \text{incidence matrix of the generated design} \\
\texttt{design}  \hspace{1cm} \text{block contents in a b by k matrix} \\
\texttt{conc.mat}  \hspace{1cm} \text{concurrence matrix of the generated design} \\
\texttt{\text{A.efficiency}}  \hspace{1cm} \text{A-efficiency of the generated design} \\
\texttt{\text{D.efficiency}}  \hspace{1cm} \text{D-efficiency of the generated design} \\
\texttt{time.taken}  \hspace{1cm} \text{time taken to generate the design}
**Author(s)**

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

**References**


**Examples**

\[ v=9 \]
\[ b=12 \]
\[ k=3 \]
\[ \text{ibdtvc}(v,b,k) \]

**Description**

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

**Usage**

\[ \text{ibdtvc}(v1,v2,b,k,NNPo,ntrial) \]

**Arguments**

- **v1**: number of test treatments
- **v2**: number of control treatments
- **b**: number of blocks
- **k**: block size
- **NNPo**: desired concurrence matrix
- **ntrial**: number of trials

**Value**

\[ v1=v1,v2=v2,b=b,k=k,design=design,N=N, NNP=NNP,Aeff=Aeff) \]

- **v1**: number of test treatments
- **v2**: number of control treatments
- **b**: number of blocks
- **k**: block size
- **design**: generated block design
is.connected

   N          incidence matrix of the generated block design
   NNP        concurrence matrix of the generated design
   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

```r
NNPo = matrix(c(7, 3, 3, 3, 3, 3, 3, 3,
                3, 7, 3, 3, 3, 3, 3, 3,
                3, 3, 7, 3, 3, 3, 3, 3,
                3, 3, 3, 7, 3, 3, 3, 3,
                3, 3, 3, 3, 7, 3, 3, 3,
                3, 3, 3, 3, 3, 7, 3, 3,
                3, 3, 3, 3, 3, 3, 9, 9,
                3, 3, 3, 3, 3, 3, 9, 9), nrow = 8, byrow = TRUE)
ibdtvc(6, 2, 15, 4, NNPo)
```

---

is.connected  Connectedness of a binary incomplete block design

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

```r
is.connected(N)
```

Arguments

- `N`  incidence matrix

Value

- `connected`  Connectedness
is.equir

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

Examples

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

is.equir  Equi-replicateness a binary incomplete block design

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-eplicated, it returns a value of 1 else it returns 0.

Usage

```
is.equir(N)
```

Arguments

N  incidence matrix

Value

equir  equi-replicated

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

Examples

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

\)

is.equir(N)

\)

is.orthogonal orthogonal

orthogonality a block design

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

is.orthogonal(N)

Arguments

N incidence matrix

Value

orthogonal orthogonal

Author(s)

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

Examples

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

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

---

**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

is.vb(N)

Arguments

N  incidence matrix

Value

vb  variance balanced

Author(s)

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

Examples

N=matrix(c(1,0,0,1,0,1,0,1,0,0,1,0,1,1,0,0,1,0,0,1,0,0,0,1,0,0,0,0,0,0),nrow=7,byrow=TRUE)
is.vb(N)

NNPmat

concurrence matrix from given incidence matrix of a block design

Description

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

Usage

NNPmat(N)

Arguments

N  incidence matrix

Value

NNP  A v by v matrix with diagonal elements as replications of treatments and off-diagonal elements as concurrences between two treatments. Here v is number of treatments.
N_to_design

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

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

N_to_design

incidence matrix from given block design

Description
This function generates the block contents from a given incidence matrix

Usage
N_to_design(N)

Arguments
N    incidence matrix

Value
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=matrix(c(1 ,0 ,0 ,1 ,0 ,1 ,1 ,
0 ,0 ,1 ,0 ,1 ,1 ,
0 ,0 ,0 ,1 ,1 ,0 ,
1 ,0 ,1 ,0 ,0 ,0 ,
0 ,1 ,0 ,1 ,0 ,0 ,
1 ,1 ,0 ,0 ,1 ,0 ,
0 ,1 ,0 ,1 ,1 ,0 ,
0 ,1 ,0 ,1 ,1 ,0 ,0
),nrow=7,byrow=TRUE)
), nrow=7, byrow=TRUE)
N_to_design(N)
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