

# Package ‘SFOCDs’

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**Type** Package

**Title** Space Filling Optimal Covariate Designs

**Version** 1.0.0

**Description** We have designed this package to address experimental scenarios involving multiple covariates. It focuses on construction of Optimal Covariate Designs (OCDs), checking space filling property of the developed design. The primary objective of the package is to generate OCDs using four methods viz., M array method, Juxtapose method, Orthogonal Integer Array and Hadamard method. The package also evaluates space filling properties of both the base design and OCDs using the MaxPro criterion, providing a meaningful basis for comparison. In addition, it includes tool to visualize the spread offered by the design points in the form of scatterplot, which help users to assess distribution and coverage of design points.

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**License** GPL (>= 2)

**Encoding** UTF-8

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**NeedsCompilation** no

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HadamardOCDs

*Hadamard Method for Optimal Covariate Designs (OCDs)***Description**

Construct Hadamard matrix  $H_k = (1, h_1, h_2, \dots, h_{k-1})$  where  $k$  is the block size of the required design. Then superimpose each columns of  $H_k$  leaving the first column which is in natural order separately into the  $N$  matrix to get the  $W$  matrices. The maximum number of  $W$  matrices will be  $k-1$ .

**Usage**

```
HadamardOCDs(design)
```

**Arguments**

`design`                      Input a design in matrix format and block size  $k$  is multiple of 4.

**Value**

Generates  $W$  matrices and Inter product sums of  $W$  matrices.

**Author(s)**

Neethu RS  
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**References**

Das, K., N. K. Mandal, and B. K. Sinha. (2003) <[https://doi.org/10.1016/S0378-3758\(02\)00151-9](https://doi.org/10.1016/S0378-3758(02)00151-9)>. Optimal experimental designs for models with covariates. Journal of Statistical Planning and Inference 115(1): 273-285.

Bansal, N., and D. K. Garg. (2022) <<https://doi.org/10.1007/s42519-022-00244-0>>. Optimum co-variate designs for three associate PBIB designs. Journal of Statistical Theory and Practice 16(3): 1-15.

**Examples**

```
library(SFOCDs)
mat<-matrix(c(1,2,3,4,1,2,4,5,1,3,4,5,2,3,4,5),nrow=4,byrow=TRUE)
HadamardOCDs(mat)
```

**Description**

Consider  $L$  matrix, construct resolvable sets by grouping columns into pairs that have the same ordered set of elements. For each pair, arrange the two column-sets horizontally ( $2(s-1)$ ) and change the signs of any two sets. This new setup form the  $P_i$  matrix of order  $2(s-1) \times 2$ . Then superimpose the first column of  $P_i$  onto  $N$  and that produce  $W_i$ , where first set of order  $v \times b$  will be  $W_i^{11}$  and other set below is  $W_i^{21}$ . Likewise use second column of  $P_i$  to get  $W_i^{12}$  and  $W_i^{22}$ . Repeat for every  $P_i$  to get collection of  $W_i$ 's. The grand total of Hadamard product of all  $W_i^{ij}$  will be zero provided a foldover of any one of the  $W_i^{ij}$  is taken.

**Usage**

JuxtaOCDs(design)

**Arguments**

design                      Input a design in matrix format and block size  $k$  such that  $(k+1)$  is a prime number.

**Value**

Generates  $W$  matrices and Inter product sums of  $W$  matrices.

**Author(s)**

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**References**

Das, K., N. K. Mandal, and B. K. Sinha. (2003) <[https://doi.org/10.1016/S0378-3758\(02\)00151-9](https://doi.org/10.1016/S0378-3758(02)00151-9)>. Optimal experimental designs for models with covariates. *Journal of Statistical Planning and Inference* 115(1): 273-285.

Bansal, N., and D. K. Garg. (2022)<<https://doi.org/10.1007/s42519-022-00244-0>>. Optimum co-variate designs for three associate PBIB designs. *Journal of Statistical Theory and Practice* 16(3): 1-15.

## Examples

```
library(SFOCDs)
mat1<-matrix(c(
  1,2,3,4,5,6,
  7,8,9,10,11,1,
  12,13,14,15,2,7,
  16,17,18,3,8,12,
  19,20,4,9,13,16,
  21,5,10,14,17,19,
  6,11,15,18,20,21),nrow=7,byrow=TRUE)
JuxtaOCDs(mat1)
```

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MaxDot

*Treatment Position Vs Treatment Scatter Plot*


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## Description

The function will give the scatter plot showing the spread offered by design points in the experimental space. The x axis of the plot represent treatments and y axis the position of treatments in each block. Different colors in the dot represent the blocks.

## Usage

```
MaxDot(design)
```

## Arguments

design                      Input a design in matrix format

## Value

Generates scatter plot of treatment position Vs treatment

## Examples

```
library(SFOCDs)
mat<-matrix(c( 1, 4, 2, 5,
  2, 5, 3, 6,
  3, 6, 1, 4,
  4, 1, 5, 2,
  5, 2, 6, 3,
  6, 3, 4, 1),nrow=6,byrow=TRUE)
MaxDot(mat)
```

Maxpro_Criterion	Maxpro Criterion
<b>Description</b>	
Maxpro Criterion	
<b>Usage</b>	
Maxpro_Criterion(design)	
<b>Arguments</b>	
design	Input a design in matrix format
<b>Value</b>	
Maxpro criterion value for a given design	
<b>Examples</b>	
<pre>library(SFOCDs) mat&lt;-matrix(c( 1,2,3, 2,1,4, 3,4,1, 4,3,2),nrow=4,byrow=TRUE) Maxpro_Criterion(mat)</pre>	
MOCDs	M Array Method for Optimal Covariate Designs (OCDs)

<b>Description</b>	
Consider Mutually Orthogonal Latin squares of order $s \times s$ , extract first column from it and make a new matrix called Initial block sequence matrix $L$ of order $s \times s-1$ . Remove the last row from the $L$ matrix and obtain the incidence matrix of it keeping zeros to the positions corresponding to the elements that were present in the deleted row of $L$ , and then remove the row that contains only non-zero elements, the square matrix thus formed is the $M$ matrix. From the columns of $M$ matrix, choose $((s-1),2)$ pairs are possible. Each of these column pairs is then superimposed to $N$ . Through this method choose $((s-1),2)$ $W$ matrices can be developed.	
<b>Usage</b>	
MOCDs(design)	

**Arguments**

design                      Input a design in matrix format and block size k such that (k+1) is a prime number.

**Value**

Generates W matrices and Inter product sums of W matrices.

**Author(s)**

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Ashutosh Dalal

**References**

Das, K., N. K. Mandal, and B. K. Sinha. (2003) <[https://doi.org/10.1016/S0378-3758\(02\)00151-9](https://doi.org/10.1016/S0378-3758(02)00151-9)>. Optimal experimental designs for models with covariates. Journal of Statistical Planning and Inference 115(1): 273-285.

Bansal, N., and D. K. Garg. (2022)<<https://doi.org/10.1007/s42519-022-00244-0>>. Optimum co-variate designs for three associate PBIB designs. Journal of Statistical Theory and Practice 16(3): 1-15.

**Examples**

```
library(SFOCDs)
mat<-matrix(c(1,2,3,4,1,2,4,5,1,3,4,5,2,3,4,5),nrow=4,byrow=TRUE)
MOCDs(mat)
```

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OIAOCDs

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*Orthogonal Integer Array Method for Optimal Covariate Designs (OCDs)*


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**Description**

Consider OIA of order same as the block size of the required design. Superimpose each array separately into the incidence matrix (N) to get the W matrices. The maximum number of W matrices depends on the column order of OIA.

**Usage**

OIAOCDs(design)

**Arguments**

design                      Input a design in matrix format and block size k such that it is an odd number.

**Value**

Generates W matrices and Inter product sums of W matrices.

**Author(s)**

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**References**

Das, K., N. K. Mandal, and B. K. Sinha. (2003) <[https://doi.org/10.1016/S0378-3758\(02\)00151-9](https://doi.org/10.1016/S0378-3758(02)00151-9)>. Optimal experimental designs for models with covariates. Journal of Statistical Planning and Inference 115(1): 273-285.

Bansal, N., and D. K. Garg. (2022)<<https://doi.org/10.1007/s42519-022-00244-0>>. Optimum co-variate designs for three associate PBIB designs. Journal of Statistical Theory and Practice 16(3): 1-15.

**Examples**

```
library(SFOCDs)
mat<-matrix(c(1,2,3,1,2,4,1,2,5,1,3,4,1,3,5,1,4,5,2,3,4,2,3,5,2,4,5,3,4,5),nrow=10,byrow=TRUE)
OIAOCDs(mat)
```

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