Package 'VdgRsm'

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Title Plots of Scaled Prediction Variances for Response Surface Designs

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Imports permute, AlgDesign

Suggests akima

Description Functions for creating variance dispersion graphs, fraction of design space plots, and contour plots of scaled prediction variances for second-order response surface designs in spherical and cuboidal regions. Also, some standard response surface designs can be generated.

License GPL (>= 2)

LazyLoad yes

NeedsCompilation no

Repository CRAN

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R topics documented:

Borkowski2003 *Small Exact D-, A-, G-, and IV-Optimal Designs*

Description

Retrieve small exact D-, A-, G-, and IV-Optimal designs generated by a genetic algorithm. These designs are catalogued by Borkowski (2003).

Usage

```
Borkowski2003(criterion, k, N)
```

Arguments

`criterion`	Only optimal criteria "D", "A", "G", and "IV" are available now.
`k`	The number of factor, k = 2 and 3
`N`	The number of design points

Value

`Borkowski2003` is called to generate the data frame of the design matrix of exact optimal designs.

References

Borkowski, J. J. (2003). *Using a Genetic Algorithm to Generate Small Exact Response Surface Designs*. Journal of Probability and Statistical Science, 1(1):65-88.

Examples

```
Borkowski2003("D", 2, 10)
Borkowski2003("G", 3, 13)
Borkowski2003("IV", 2, 7)
Borkowski2003("A", 3, 15)
```

cpv *Cuboidal Prediction Variance*

Description

Create a variance dispersion graph for a response surface design in a cuboidal region.

Usage

```
cpv(design.matrix, design.matrix.2 = NULL, des.names = c("Design 1","Design 2"),
    add.pts = TRUE)
```

Arguments

design.matrix, design.matrix.2
: Data frames of design points to be compared in coded or uncoded units. There should be one column for each factor in the design, and one row for each run in the design. The maximum number of factors is 6. If the number of factor is more than 4, only one design is allowed.

add.pts
: Generate scaled prediction variances of random design points in the VDG. By default add.pts = TRUE.

des.names
: A vector of descriptive names for designs in character strings.

Value

cpv is called to generate a variance sispersion graph when the number of factors k = 2, 3, or 4 and to generate side-by-side boxplots for k = 5 and 6. In the former case, a table of the minimum, maximum, and average of scaled prediction variances is also produced.

Examples

```
CCD1<- gen.CCD(n.vars = 3, n.center = 2, alpha = 1)
CCD2<- gen.CCD(n.vars = 3, n.center = 5, alpha = 1)
cpv(CCD1, CCD2, des.names = c("CCD with nc=2", "CCD with nc=5"), add.pts = FALSE)
```

fds.cube *The Fraction of Design Space (FDS) plots for cuboidal-region designs*

Description

Create fraction of design space plots for response surface designs in cuboidal regions.

Usage

```
fds.cube(design.matrix, design.matrix.2 = NULL, design.matrix.3 = NULL,
         des.names = c("Design 1","Design 2","Design 3"))
```

Arguments

design.matrix, design.matrix.2, design.matrix.3
: Data frames of design points to be compared in coded or uncoded units. There should be one column for each factor in the design, and one row for each run in the design. The maximum number of factors is 6.

des.names
: A vector of descriptive names for designs in character strings.

Value

fds.sphere is called to generate fraction of design space plots for cuboidal-region designs.

Examples

```
CCD1<- gen.CCD(n.vars = 4, n.center = 2, alpha = 1)
CCD2<- gen.CCD(n.vars = 4, n.center = 5, alpha = 1)
fds.cube(CCD1, CCD2)
```

---

fds.sphere — *The Fraction of Design Space (FDS) plots for spherical-region designs*

Description

Create fraction of design space plots for response surface designs in spherical regions.

Usage

```
fds.sphere(design.matrix, design.matrix.2 = NULL, design.matrix.3 = NULL,
        des.names = c("Design 1","Design 2","Design 3"), scale = TRUE, label = "ON")
```

Arguments

design.matrix, design.matrix.2, design.matrix.3
: Data frames of design points to be compared in coded or uncoded units. There should be one column for each factor in the design, and one row for each run in the design. The maximum number of factors is 7.

des.names
: A vector of descriptive names for designs in character strings.

scale
: Design points are scaled by a factor equal to the square root of the number of factors divided by the maximum of radii across the set of design points. This factor makes two or more designs comparable by scaling the maximum design point radius to be the square root of the number of factors.

label
: The default is "ON" meaning that all legends will be appeared, and if it is "OFF", legends will be removed.

Value

fds.sphere is called to generate Fraction of Design Space plots for spherical-region designs.

Examples

```
CCD1<- gen.CCD(n.vars = 2, n.center = 2, alpha = 1)
CCD2<- gen.CCD(n.vars = 2, n.center = 2, alpha = sqrt(2))
fds.sphere(CCD1, CCD2)
```

---

gen.BBD *Box-Behnken Designs (BBDs)*

Description

Generate Box-Behnken designs for k = 3 to 7

Usage

```
gen.BBD(k, n.center = 1)
```

Arguments

k	The number of factors or independent variables, k = 3 to 7.
n.center	The number of center points

Value

`gen.BBD` is called to generate the data frame of the design matrix of the BBD.

References

SAS 9.1 ADX Interface for Design of Experiments. Cary, NC: SAS Institute Inc.

Examples

```
gen.BBD(3)
gen.BBD(4, n.center = 3)
gen.BBD(7, n.center = 5)
```

gen.CCD *Central Composite Designs*

Description

Generate central composite designs

Usage

```
gen.CCD(n.vars, n.center, alpha, varNames)
```

Arguments

n.vars	The number of factors or independent variables
n.center	The number of center points
alpha	The axial distance
varNames	The variable names. If it is not provided, the default names are X1,X2,...,Xk

Value

`gen.CCD` is called to generate the data frame of the design matrix of the CCD

Examples

```
CCD1<- gen.CCD(n.vars = 3, n.center = 2, alpha = 1)
CCD2<- gen.CCD(n.vars = 3, n.center = 2, alpha = 1, varNames = c("T1","T2","T3"))
```

gen.Factr *Factorial Designs*

Description

Generate factorial designs

Usage

```
gen.Factr(n.vars, n.levels, varNames = NULL, scale = TRUE)
```

Arguments

n.vars	The number of factors or independent variables
n.levels	The number of levels of the factor
varNames	The names of factors. If it is not provided, the default names are X1, X2,..., Xk.
scale	If it is `scale = TRUE`, the level values will be scaled to -1 to 1.

Value

`gen.Factr` is called to generate the data frame of the design matrix of the factorial design.

Examples

```
CCD1<- gen.Factr(n.vars = 3, n.levels = 5)
CCD2<- gen.Factr(n.vars = 3, n.levels = 5, varNames = c("T1","T2","T3"), scale = FALSE)
```

---

gen.HSCD *Hartley's Small Composite Designs (HSCDs)*

Description

Generate Hartley's small composite designs for k = 2 to 7

Usage

```
gen.HSCD(k, alpha ="rotatable", n.center = 0)
```

Arguments

k	The number of factors or independent variables, k = 2, 3, 4, 5, 6, and 7.
alpha	Axial distance. User may specify "rotatable", "face-center", or other numeric numbers. See examples.
n.center	The number of center points

Value

`gen.HSCD` is called to generate the data frame of the design matrix of the HSCD

References

SAS 9.1 ADX Interface for Design of Experiments. Cary, NC: SAS Institute Inc.

Examples

```
gen.HSCD(3)
gen.HSCD(4, alpha ="face-center")
gen.HSCD(7, alpha = 2, n.center = 4)
```

gen.PBCD *Plackett-Burman Composite Designs (Draper and Lin's Method)*

Description

Generate Plackett-Burman composite designs proposed by Draper and Lin (1990) for k = 3 to 7

Usage

```
gen.PBCD(k, alpha ="rotatable", n.center = 0)
```

Arguments

`k`	The number of factors or independent variables, k = 3 to 7.
`alpha`	Axial distance. User may specify "rotatable", "face-center", or other numeric numbers. See examples.
`n.center`	The number of center points

Value

`gen.PBCD` is called to generate the data frame of the design matrix of the PBCD

References

SAS 9.1 ADX Interface for Design of Experiments. Cary, NC: SAS Institute Inc.

Examples

```
gen.PBCD(3)
gen.PBCD(4, alpha = 1)
gen.PBCD(5, alpha = "face-center", n.center = 3)
gen.PBCD(6, alpha = 2, n.center = 5)
```

gen.Roquemore *Roquemore's Hybrid Designs*

Description

Generate Roquemore (1976) hybrid designs for k = 3, 4, and 6. For k = 3, R310, R311A, and R311B will be produced, for k = 4, R416A, R416B, and R416C will be generated, and for k = 6 R628A and R628B will be given.

Usage

```
gen.Roquemore(k, n.center = 0)
```

Arguments

`k`	The number of factors or independent variables, k = 3, 4, and 6.
`n.center`	The number of center points

Value

`gen.Roquemore` will retrieve the hybrid design points stored and the output is a list containing relevant Roquemore's designs given a k value.

References

SAS 9.1 ADX Interface for Design of Experiments. Cary, NC: SAS Institute Inc.

Examples

```
gen.Roquemore(3)
gen.Roquemore(4, n.center = 2)
gen.Roquemore(6, n.center = 1)
```

`gen.USD` *Doehlert's Uniform Shell Designs (USDs)*

Description

Generate uniform shell designs for k = 2 to 6

Usage

```
gen.USD(k, alpha = 1)
```

Arguments

`k`	The number of factors or independent variables, k = 2 to 6.
`alpha`	A scaling factor. See examples.

Value

`gen.USD` is called to generate the data frame of the design matrix of the USD.

References

Doehlert, D. H (1970), *Uniform Shell Designs*, Journal of the Royal Statistical Society, 19(3):231-239

Examples

```
gen.USD(2)
gen.USD(3, alpha = sqrt(3))
gen.USD(6)
gen.USD(6, alpha = sqrt(6))
```

`hyperarcs.vdg` *Scaled prediction variance in nested cubes*

Description

Create a graph of scaled prediction variances for points in nested cubes (hyperarcs)

Usage

```
hyperarcs.vdg(design.matrix, design.matrix.2 = NULL, design.matrix.3 = NULL,
          des.names = c("Design 1","Design 2","Design 3"))
```

Arguments

`design.matrix, design.matrix.2, design.matrix.3`
: Data frames of design points to be compared in coded or uncoded units. There should be one column for each factor in the design, and one row for each run in the design. The minimum and maximum number of factors are 3 and 6, respectively.

`des.names`
: A vector of descriptive names for designs in character strings.

Value

`hyperarcs.vdg` is called to generate a plot of scaled prediction variances on hyperarcs.

Examples

```
CCD1<- gen.CCD(n.vars = 3, n.center = 2, alpha = 1)
CCD2<- gen.CCD(n.vars = 3, n.center = 5, alpha = 1)
hyperarcs.vdg(CCD1, CCD2)
```

spv *Spherical Prediction Variance*

Description

Create variance dispesion graphs (VDGs) for response surface designs in spherical regions.

Usage

```
spv(design.matrix, design.matrix.2 = NULL, design.matrix.3 = NULL,
    des.names = c("Design 1","Design 2","Design 3"),
    scale = TRUE, add.pts = TRUE, label = "ON")
```

Arguments

design.matrix, design.matrix.2, design.matrix.3
: Data frames of design points to be compared in coded or uncoded units. There should be one column for each factor in the design, and one row for each run in the design. The maximum number of factors is 7.

des.names
: A vector of descriptive names for designs in character strings.

scale
: Design points are scaled by a factor equal to the square root of the number of factors divided by the maximum of radii across the set of design points. This factor makes two or more designs comparable by scaling the maximum design point radius to be the square root of the number of factors.

add.pts
: Generate scaled prediction variances of random design points in the VDG. By default add.pts = TRUE.

label
: The default is "ON" meaning that all legends will be appeared, and if it is "OFF", legends will be removed.

Value

spv is called to generate the Variance Dispersion Graph(s) and a table of the minimum, maximum, and average of scaled prediction variances.

Examples

```
CCD1<- gen.CCD(n.vars = 3, n.center = 2, alpha = 1)
CCD2<- gen.CCD(n.vars = 3, n.center = 2, alpha = sqrt(3))
spv(CCD1, CCD2, des.names = c("CCD 1","CCD 2"))
```

spvcontour *Contour Plot of Scaled Prediction Variances*

Description

Create a contour plot of scaled prediction variances

Usage

```
spvcontour(design.matrix, shape, max.radius = sqrt(2), length = 100,
nlevels = 10, title = "Contour of SPVs")
```

Arguments

design.matrix	A data frame of design points. There should be one column for each factor in the design, and one row for each run in the design. Only design with 2 factors is allowed.
shape	The shape can be "circle" or "square" which represent a shape of design space.
max.radius	The radius of a circle.
length	Argument from the interp fucntion in library akima.
nlevels	Argument from the interp fucntion in library akima.
title	The title of a contour plot.

Value

spvcontour is called to generate a contour plot of scaled prediction variances for response surface designs.

Examples

```
library(akima)
CCD1<- gen.CCD(n.vars = 2, n.center = 2, alpha = 1)
spvcontour(CCD1, shape = "square")
CCD2<-gen.CCD(n.var = 2, alpha = sqrt(2), n.center = 3)
spvcontour(CCD2, shape = "circle")
spvcontour(CCD2, shape = "circle", length = 200)
spvcontour(CCD2, shape = "circle", length = 200, nlevels = 20)
```

VdgRsm *Plots of Scaled Prediction Variances for Response Surface Designs*

Description

Functions for creating variance dispersion graphs, fraction of design space plots, and contour plots of scaled prediction variances for second-order response surface designs in spherical and cuboidal regions. Also, some standard response surface designs can be generated.

Details

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Author(s)

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References

1. Borkowski J.J. (2003), "Using a Genetic Algorithm to Generate Small Exact Response Surface Designs", Journal of Probability and Statistical Science, 1(1):65-88.
2. Borkowski J.J. (2005), Chapter 14: "Graphical Methods for Assessing the Prediction Capability of Response Surface Designs" In Khuri, A.I., "Response Surface Methodology and Related Topics", p.349-375, World Scientific Publishing.
3. Doehlert, D. H (1970), "Uniform Shell Designs"", Journal of the Royal Statistical Society, 19(3):231-239.
4. Giovannitti-Jensen, A. and Myers, R.H. (1989), "Graphical Assessment of the Prediction Capability of Response Surface Designs", Technometrics, 31, p.159-171.
5. Khuri, A.I., Kim, H.J., and Um Y. (1996), "Quantile plots of the prediction variance for response surface designs", Computational Statistics and Data Analysis, 22, p.395-407.
6. Nguyen, N.K. and Borkowski, J.J. (2008), "New 3-Level Response Surface Designs Constructed from Incomplete Block Designs", Journal of Statistical Planning and Inference, 138, p.294-305.
7. Rozum, M.A. and Myers, R.H. (1991), "Adaptation of Variance Dispersion Graphs to Cuboidal Regions of Interest", Presented at Joint Statistical Meetings, American Statistical Association, Atlanta, GA.
8. SAS 9.1 ADX Interface for Design of Experiments. Cary, NC: SAS Institute Inc.
9. Zahran, A., Anderson-Cook, C.M., and Myers, R.H. (2003), "Fraction of Design Space to Assess the Prediction Capability of Response Surface Designs", Journal of Quality Technology, 35, p.377-386.

See Also

The CRAN task view on Design of Experiments

Index