Package ‘UniDOE’

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Title Uniform Design of Experiments
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Description Efficient procedures for constructing uniform design of experiments under various space-filling criteria. It is based on a stochastic and adaptive threshold accepting algorithm with flexible initialization, adaptive threshold, and stochastic evolution. The package may also construct the augmented uniform designs in a sequential manner.
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Evaluate design in terms of criteria

Description
This function takes matrix X0,q and crit to output the criterion value.

Usage
DesignEval(X0,crit)

Arguments
X0 an integer matrix object
crit an integer object, criterion to choose:
"MD2" – MD2
"CD2" – CD2
"WD2" – WD2
"maximin" – maximin
Default: "MD2"

Value
criterion value.

Author(s)
Aijun Zhang, Haoyu Li, Shijie Quan

References

Examples
x0 = matrix(c(1,1,1,2,2,2,3,3,3),nrow=3,byrow=TRUE)
crit="MD2"
value = DesignEval(x0,crit)
DesignPairPlot

Draw pair plot for design of experiments

Description
This function takes a design D and a boolean value Diag to draw pair plot.

Usage
DesignPairPlot(D,Diag)

Arguments
- D: a matrix object. Design of Experiment.
- Diag: a boolean R object.

Value
A pair plot

Author(s)
Aijun Zhang, Haoyu Li, Shijie Quan

References

Examples
```R
# e.g. 1
n=12 #(must be multiples of q)
s=3
q=4
crit = "MD2" # (Mixture L2 criteria)
D = DesignQuery(n=n,s=s,q=q,crit="MD2")
DesignPairPlot(D)

# e.g. 2
n=12 #(must be multiples of q)
s=3
q=3
crit = "MD2" # (Mixture L2 criteria)
D = DesignQuery(n=n,s=s,q=q,crit="MD2")
DesignPairPlot(D,Diag=TRUE)
```
DesignQuery

Evaluate design in terms of criteria

Description

This function takes size of desired design, criterion crit. If the required design exists in database, then return the design, else return NULL.

Usage

DesignQuery(n, s, q, crit, ShowCrit)

Arguments

- n: an integer R object. Run of Experiment
- s: an integer R object. Factor of Experiment.
- q: an integer R object. Level of Experiment.
- crit: an integer object, criterion to choose:
  - "MD2" – MD2
  - "CD2" – CD2
  - "maximin" – maximin
  Default: "CD2"
- ShowCrit: If TRUE, print CD2, MD2, maximin value of required design. Default: TRUE

Value

Desired design

Author(s)

Aijun Zhang, Haoyu Li, Shijie Quan

References


Examples

```r
n = 9
s = 3
q = 3
crit="MD2"
D = DesignQuery(n, s, q, crit)
D
```
Generating Augmented Uniform Design of Experiments

Description
This function takes n, s, q; a unchanged initial design and other arguments to output a list (described below).

Usage
GenAUD(X0, n, crit, maxiter, hits_ratio, vis)

Arguments
- **X0**: an integer matrix R object
- **n**: an integer R object. Run of Experiment
- **crit**: an character R object. Type of criterion to use. "maximin" – maximin Discrepancy; "CD2" – Centered L2 Discrepancy; "WD2" – Wrap-around L2 Discrepancy; "MD2" – Mixture L2 Discrepancy;
- **maxiter**: a positive integer R object. Maximum iteration number in outer while loop of SOAT algorithm.
- **hits_ratio**: an float R object. Default value is 0.1, which is the ratio to accept changes of design in inner for loop. Details can be checked in (Zhang, A. and Li, H. (2017). UniDOE: An R package for constructing uniform design of experiments via stochastic and adaptive threshold accepting algorithm. Technical Report.)
- **vis**: an boolean variable. If true, plot the trace of criterion values.

Value
A list that contains Initial design matrix(initial_design), optimal design matrix(final_design), initial criterion value(initial_criterion), final criterion value(criterion_value) and criterion list(criterion_lists) in update process.

Author(s)
Aijun Zhang, Haoyu Li, Shijie Quan

References
Examples

# Example 1.
# Set a fixed initial matrix:
n=12 # (must be multiples of q)
mat0 = matrix(c(1,1,2,2,2,3,3,3), ncol=3, byrow=TRUE) # nb. of columns=s
crit = "MD2" # (Mixture L2 criteria)
res = GenAUD(X0=mat0, n, crit=crit, maxiter=100)

# Example 2.
# Set a fixed initial matrix with visualization:
n=9 # (must be multiples of q)
mat0 = matrix(c(1,1,2,2,2,3,3,3), ncol = 3, byrow = TRUE)
crit = "MD2" # (Mixture L2 criteria)
list1=GenAUD(X0=mat0, n, crit=crit, vis=TRUE, maxiter=100)

GenAUD_MS  Generating sequential Uniform Design of Experiments using different initial designs

Description

This function takes n, s, q and other arguments to output a list (described below).

Usage

GenAUD_MS(X0, n, crit, maxiter, nshoot, vis=FALSE)

Arguments

X0 an integer matrix R object. Fixed design to be used.
n an integer R object. Number of rows to be added to design
crit an character R object. Type of criterion to use.
"maximin" – maximin Discrepancy;
"CD2" – Centered L2 Discrepancy;
"WD2" – Wrap-around L2 Discrepancy;
"MD2" – Mixture L2 Discrepancy;
maxiter a positive integer R object. Maximum iteration number in outer while loop of SATA algorithm in each shoot.
nshoot Total counts to try different initial designs.
vis an boolean R object. If true, plot the criterion value sequence for all shoots.

Value

Best design over all shoots.
Author(s)
Aijun Zhang, Haoyu Li, Shijie Quan

References

Examples
```r
dQ = designqueryHn = 18, s = 7, q = 3L crit = "MD2"I
dR = genaud_msHxP=dQ+QL n=QXL crit="MD2"L
    maxiter = 100, nshoot = 5,
    vis = TRUEI
```

GenLP
Generating uniform designs by level permutation

Description
Function for generating uniform designs by level permutation. It can be also used to improve a user-specified design with randomized level permutation.

Usage
```r
GenLP(X0, crit, maxiter, hits_ratio, vis)
```

Arguments
- `X0` Current design
- `crit` an character R object. Type of criterion to use.
  - "maximin" – maximin Discrepancy;
  - "CL2" – Centered L2 Discrepancy;
  - "WD2" – Wrap-around L2 Discrepancy;
  - "MD2" – Mixture L2 Discrepancy;
- `maxiter` a positive integer R object
- `hits_ratio` an float R object. Default value is 0.1, which is the ratio to accept changes of design in inner for loop. Details can be checked in (Zhang, A. and Li, H. (2017). UniDOE: An R package for constructing uniform design of experiments via stochastic and adaptive threshold accepting algorithm. Technical Report.)
- `vis` an boolean R object. If true, plot the criterion value sequence.

Value
A list that contains Initial design matrix(initial_design), optimal design matrix(final_design), initial criterion value(initial_criterion), final criterion value(criterion_value) and criterion list(criterion_lists) in update process.
Author(s)

Aijun Zhang, Haoyu Li, Shijie Quan

References


Examples

```r
n=27 # (must be multiples of q)
s=13
q=3
crit = "MD2" # (Mixture L2 criteria)
res1 = GenUD(n,s,q,crit=crit,maxiter=100)
res2 = GenUD(res1$final_design,vis=TRUE, maxiter=100) # To improve ...
```

---

GenUD

Generating Uniform Design of Experiments

Description

This function takes n,s,q and other arguments to output a list(described below).

Usage

```r
GenUD(n,s,q,init,initX,crit,maxiter,hits_ratio,vis)
```

Arguments

- **n**: an integer R object. Run of Experiment.
- **s**: an integer R object. Factor of Experiment.
- **q**: an integer R object. Level of Experiment.
- **init**: an string vector R object: "rand" (default), "orth" or "input". Criterion used.
- **initX**: an user-defined integer matrix R object, which is fixed in search. Needed when init="orth" or init="input".
- **crit**: an character R object. Type of criterion to use.
  - "maximin" – maximin Discrepancy;
  - "CD2" – Centered L2 Discrepancy;
  - "WD2" – Wrap-around L2 Discrepancy;
  - "MD2" – Mixture L2 Discrepancy;
- **maxiter**: a positive integer R object. Maximum iteration number in outer while loop of SATA algorithm.
hits_ratio an float R object. Default value is 0.1, which is the ratio to accept changes of design in inner for loop. Details can be checked in (Zhang, A. and Li, H. (2017). UniDOE: An R package for constructing uniform design of experiments via stochastic and adaptive threshold accepting algorithm. Technical Report.)

vis an boolean R object. If true, plot the criterion value sequence.

Value
A list that contains Initial design matrix(initial_design), optimal design matrix(final_design), initial criterion value(initial_criterion), final criterion value(criterion_value) and criterion list(criterion_lists) in update process.

Author(s)
Aijun Zhang, Haoyu Li, Shijie Quan

References

Examples
```r
## e.g. 1
n=12 #(must be multiples of q)
s=3
q=4
crit = "MD2" #(Mixture L2 criteria)
res = GenUD(n,s,q,crit=crit,maxiter=100)

## e.g. 2
n=10 #(must be multiples of q)
s=3
q=5
init = "rand"
crit = "MD2" #(Mixture L2 criteria)
vis=TRUE
res=GenUD(n,s,q,init=init,crit=crit,maxiter=100,vis=vis)

## e.g. 3
# If init = "orth", # algorithm will fix columns of initx and expand total number of columns to s for final design.
s=5
init = "orth" # initx should be orthogonal design with nrow=n&level=q
initx = matrix(c(1,1,2,2,3,3,3,3,1,1,2,2), ncol=2)
res = GenUD(s=s,init=init,initx=initx,maxiter=100)

## e.g. 4
# If init="input", algorithm will search for better a better design with same size as initx.
init = "input"
```
# initx should be orthogonal design with nrow=n&level=q
initx = matrix(c(1,1,2,2,3,3,3,3,1,1,2,2),ncol=2)
res = GenUD(init=init,initx = initx,maxiter=100)

---

**GenUD_MS**

*Generating Uniform Design of Experiments using different initial designs*

**Description**

This function takes n,s,q,crit and nshoot to return a design. nshoot number of random initial designs are used in each shoot. The design returned is the best design over all shoots.

**Usage**

GenUD_MS(n, s, q, crit, maxiter, nshoot, vis)

**Arguments**

- **n**: an integer R object. Run of Experiment
- **s**: an integer R object. Factor of Experiment.
- **q**: an integer R object. Level of Experiment.
- **crit**: an character R object. Type of criterion to use.
  - "maximin" – maximin Discrepancy ;
  - "CD2" – Centered L2 Discrepancy ;
  - "WD2" – Wrap-around L2 Discrepancy;
  - "MD2" – Mixture L2 Discrepancy;
- **maxiter**: a positive integer R object. Maximum iteration number in outer while loop of SATA algorithm in each shoot.
- **nshoot**: Total counts to try different initial designs.
- **vis**: an boolean R object. If true, plot the criterion value sequence for all shoots.

**Value**

Best design over all shoots.

**Author(s)**

Aijun Zhang, Haoyu Li, Shijie Quan

**References**

**LHD_CD2**

**Examples**

```r
D = genUD_MS(36, 4, 6, crit="CD2",
    maxiter=50, nshoot = 6,
    vis=TRUE)
```

---

**LHD_CD2**

**LHD Tables under CD2**

**Description**

Latin Hypercube designs constructed by CD2 criterion

**Usage**

```r
data(LHD_CD2)
```

**Format**

A list containing (n,q,CD2,WD2) and the design matrix

---

**LHD_MD2**

**LHD Tables under MD2**

**Description**

Latin Hypercube designs constructed by MD2 criterion

**Usage**

```r
data(LHD_MD2)
```

**Format**

A list containing (n,q,CD2,WD2) and the design matrix
**UD_CD2**

*UD Tables under CD2*

**Description**

Uniform designs constructed by CD2 criterion

**Usage**

`data(UU_CD2)`

**Format**

A list containing (n,s,q,CD2,WD2) and the design matrix

---

**UD_MD2**

*UD Tables under MD2*

**Description**

Uniform designs constructed by MD2 criterion

**Usage**

`data(UU_MD2)`

**Format**

A list containing (n,s,q,CD2,WD2) and the design matrix

---

**UniTracePlot**

*Draw discrepancy value trace in optimization process.*

**Description**

This function takes an output from GenUD or GenAUD function and a integer value skip to draw trace plot.

**Usage**

`UniTracePlot(output, skip=0)`
**UniTracePlot**

**Arguments**

- **output**: an output from GenUD or GenAUD function.
- **skip**: an integer value. Number of values in the head to skip for the given sequence.

**Value**

A trace plot

**Author(s)**

Aijun Zhang, Haoyu Li, Shijie Quan

**References**


**Examples**

```r
# e.g.
n=12 # (must be multiples of q)
s=3
q=4
Dlst = GenUD(n=n,s=s,q=q,crit="MD2",maxiter=100)
UniTracePlot(output=Dlst)
```
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