Package ‘OBsMD’

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Title Objective Bayesian Model Discrimination in Follow-Up Designs

Version 11.1

Description Implements the objective Bayesian methodology proposed in Consonni and Deldossi in order to choose the optimal experiment that better discriminate between competing models, see Deldossi and Nai Ruscone (2020) <doi:10.18637/jss.v094.i02>.

License GPL (>= 2)

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`OBsMD-package` *Objective Bayesian Model Discrimination in Follow-Up Designs*

Description

Implements the objective Bayesian methodology proposed in Consonni and Deldossi in order to choose the optimal experiment that better discriminate between competing models.

Details

Package:	OBsMD
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License:	GPL version 3 or later

The packages allows you to perform the calculations and analyses described in Consonni and Deldossi paper in TEST (2016), Objective Bayesian model discrimination in follow-up experimental designs.

Author(s)

Author: Laura Deldossi and Marta Nai Ruscone based on Daniel Meyer's code.\ Maintainer: Marta Nai Ruscone <marta.nairuscone@unige.it>

References

Deldossi, L., Nai Ruscone, M. (2020) R Package OBsMD for Follow-up Designs in an Objective Bayesian Framework. *Journal of Statistical Software* **94**(2), 1–37. doi:10.18637/jss.v094.i02.

Consonni, G. and Deldossi, L. (2016) Objective Bayesian Model Discrimination in Follow-up design., *Test* **25**(3), 397–412. doi:10.1007/s1174901504613.

Box, G. E. P. and Meyer R. D. (1986) An Analysis of Unreplicated Fractional Factorials., *Technometrics* **28**(1), 11–18. doi:10.1080/00401706.1986.10488093.

Box, G. E. P. and Meyer R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

Meyer, R. D., Steinberg, D. M. and Box, G. E. P. (1996) Follow-Up Designs to Resolve Confounding in Multifactor Experiments (with discussion)., *Technometrics* **38**(4), 303–332. doi:10.2307/1271297.

Examples

```
data(BM86.data)
```

`BM86.data` *Data sets in Box and Meyer (1986)*

Description

Design factors and responses used in the examples of Box and Meyer (1986)

Usage

```
data(BM86.data)
```

Format

A data frame with 16 observations on the following 19 variables.

X1 numeric vector. Contrast factor.

X2 numeric vector. Contrast factor.

X3 numeric vector. Contrast factor.

X4 numeric vector. Contrast factor.

X5 numeric vector. Contrast factor.

X6 numeric vector. Contrast factor.

X7 numeric vector. Contrast factor.

X8 numeric vector. Contrast factor.

X9 numeric vector. Contrast factor.

X10 numeric vector. Contrast factor.

X11 numeric vector. Contrast factor.

X12 numeric vector. Contrast factor.

X13 numeric vector. Contrast factor.

X14 numeric vector. Contrast factor.

X15 numeric vector. Contrast factor.

y1 numeric vector. Log drill advance response.

y2 numeric vector. Tensile strength response.

y3 numeric vector. Shrinkage response.

y4 numeric vector. Yield of isatin response.

References

Box, G. E. P. and Meyer, R. D. (1986) An Analysis of Unreplicated Fractional Factorials., *Technometrics* **28**(1), 11–18. doi:10.1080/00401706.1986.10488093.

Examples

```
library(OBsMD)
data(BM86.data,package="OBsMD")
print(BM86.data)
```

BM93.e1.data *Example 1 data in Box and Meyer (1993)*

Description

12-run Plackett-Burman design from the 2^5 reactor example from Box, Hunter and Hunter (1977).

Usage

```
data(BM93.e1.data)
```

Format

A data frame with 12 observations on the following 7 variables.

Run a numeric vector. Run number from a 2^5 factorial design in standard order.

A a numeric vector. Feed rate factor.

B a numeric vector. Catalyst factor.

C a numeric vector. Agitation factor.

D a numeric vector. Temperature factor.

E a numeric vector. Concentration factor.

y a numeric vector. Percent reacted response.

References

Box, G. E. P., Hunter, W. C. and Hunter, J. S. (1978) *Statistics for Experimenters*. Wiley.

Box, G. E. P. and Meyer, R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

Examples

```
library(OBsMD)
data(BM93.e1.data,package="OBsMD")
print(BM93.e1.data)
```

BM93.e2.data *Example 2 data in Box and Meyer (1993)*

Description

12-run Plackett-Burman design for the study of fatigue life of weld repaired castings.

Usage

```
data(BM93.e2.data)
```

Format

A data frame with 12 observations on the following 8 variables.

A a numeric vector. Initial structure factor.

B a numeric vector. Bead size factor.

C a numeric vector. Pressure treat factor.

D a numeric vector. Heat treat factor.

E a numeric vector. Cooling rate factor.

F a numeric vector. Polish factor.

G a numeric vector. Final treat factor.

y a numeric vector. Natural log of fatigue life response.

References

Hunter, G. B., Hodi, F. S., and Eager, T. W. (1982) High-Cycle Fatigue of Weld Repaired Cast Ti-6A1-4V., *Metallurgical Transactions* **13**(9), 1589–1594.

Box, G. E. P. and Meyer, R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

Examples

```
library(OBsMD)
data(BM93.e2.data,package="OBsMD")
print(BM93.e2.data)
```

BM93.e3.data *Example 3 data in Box and Meyer (1993)*

Description

2^{8-4} Fractional factorial design in the injection molding example from Box, Hunter and Hunter (1978).

Usage

```
data(BM93.e3.data)
```

Format

A data frame with 20 observations on the following 10 variables.

blk a numeric vector

A a numeric vector. Mold temperature factor.

B a numeric vector. Moisture content factor.

C a numeric vector. Holding Pressure factor.

D a numeric vector. Cavity thickness factor.

E a numeric vector. Booster pressure factor.

F a numeric vector. Cycle time factor.

G a numeric vector. Gate size factor.

H a numeric vector. Screw speed factor.

y a numeric vector. Shrinkage response.

References

Box G. E. P., Hunter, W. C. and Hunter, J. S. (1978) *Statistics for Experimenters*. Wiley.

Box G. E. P., Hunter, W. C. and Hunter, J. S. (2004) *Statistics for Experimenters II*. Wiley.

Box, G. E. P. and Meyer, R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

Examples

```
library(OBsMD)
data(BM93.e3.data,package="OBsMD")
print(BM93.e3.data)
```

combinations *Enumerate the Combinations of the Elements of a Vector*

Description

`combinations` enumerates the possible combinations of a specified size from the elements of a vector.

Usage

```
combinations(n, r, v=1:n, set=TRUE, repeats.allowed=FALSE)
```

Arguments

`n`	Size of the source vector
`r`	Size of the target vectors
`v`	Source vector. Defaults to `1:n`
`set`	Logical flag indicating whether duplicates should be removed from the source vector `v`. Defaults to `TRUE`.
`repeats.allowed`	Logical flag indicating whether the constructed vectors may include duplicated values. Defaults to `FALSE`.

Details

Caution: The number of combinations increases rapidly with `n` and `r`!.

To use values of `n` above about 45, you will need to increase R's recursion limit. See the `expression` argument to the `options` command for details on how to do this.

Value

Returns a matrix where each row contains a vector of length `r`.

Author(s)

Original versions by Bill Venables <`Bill.Venables@cmis.csiro.au`>. Extended to handle `repeats.allowed` by Gregory R. Warnes <`greg@warnes.net`>.

References

Venables, Bill. "Programmers Note", R-News, Vol 1/1, Jan. 2001. https://cran.r-project.org/doc/Rnews/

Examples

```
combinations(3,2,letters[1:3])
combinations(3,2,c(1:3),repeats=TRUE)
combinations(6,3,1:6,repeats=TRUE)



# To use large 'n', you need to change the default recusion limit
options(expressions=1e5)
cmat <- combinations(100,2)
dim(cmat) # 4950 by 2
```

MetalCutting *Data sets in Edwards, Weese and Palmer (2014)*

Description

Design factors and responses used in the examples of Edwards, Weese and Palmer (2014)

Usage

```
data(MetalCutting)
```

Format

A data frame with 64 observations on the following 8 variables.

blk block

A numeric vector. Tool speed.

B numeric vector. Workpiece speed.

C numeric vector. Depth of cut.

D numeric vector. Coolant.

E numeric vector. Direction of cut.

F numeric vector. Number of cut.

Ytransformed numeric vector. Response.

References

Edwards, D. J. P., Weese, M. L. and Palmer, G. A. (2014) Comparing methods for design follow-uprevisiting a metal-cutting case study., *Applied Stochastic Models in Business and Industry* **30**(4), 464–478. doi:10.1002/asmb.1988

Examples

```
library(OBsMD)
data(MetalCutting,package="OBsMD")
print(MetalCutting)
```

`OBsMD.es5` *OBsMD.es5*

Description

Data of the Reactor Experiment from Box, Hunter and Hunter (1978).

Usage

```
data(OBsMD.es5)
```

Format

A data frame with 8 observations on the following 6 variables.

A numeric vector. Contrast factor.

B numeric vector. Contrast factor.

C numeric vector. Contrast factor.

D numeric vector. Contrast factor.

E numeric vector. Contrast factor.

y numeric vector. Response.

References

Box G. E. P., Hunter, W. C. and Hunter, J. S. (1978) *Statistics for Experimenters*. Wiley.

Box G. E. P., Hunter, W. C. and Hunter, J. S. (2004) *Statistics for Experimenters II*. Wiley.

Examples

```
library(OBsMD)
data(OBsMD.es5,package="OBsMD")
print(OBsMD.es5)
```

`OBsProb` *Objective Posterior Probabilities from Bayesian Screening Experiments*

Description

Objective model posterior probabilities and marginal factor posterior probabilities from Bayesian screening experiments according to Consonni and Deldossi procedure.

Usage

```
OBsProb(X, y, abeta=1, bbeta=1, blk, mFac, mInt, nTop)
```

Arguments

X	Matrix. The design matrix.
y	vector. The response vector.
abeta	First parameter of the Beta prior distribution on model space
bbeta	Second parameter of the Beta prior distribution on model space
blk	integer. Number of blocking factors (>=0). These factors are accommodated in the first columns of matrix X. There are ncol(X)-blk design factors.
mFac	integer. Maximum number of factors included in the models.
mInt	integer <= 3. Maximum order of interactions among factors considered in the models.
nTop	integer <=100. Number of models to print ordered according to the highest posterior probability.

Details

Model and factor posterior probabilities are computed according to Consonni and Deldossi Objective Bayesian procedure. The design factors are accommodated in the matrix X after blk columns of the blocking factors. So, ncol(X)-blk design factors are considered. A BETA(ABETA, BBETA) distribution is assumed as a prior on model space. The function calls the FORTRAN subroutine 'obm' and captures summary results. The complete output of the FORTRAN code is save in the 'OBsPrint.out' file in the working directory. The output is a list of class OBsProb for which print, plot and summary methods are available.

Value

Below a list with all output parameters of the FORTRAN subroutine 'obm'. The names of the list components are such that they match the original FORTRAN code. Small letters are used for capturing program's output.

X	matrix. The design matrix.
Y	vector. The response vector.
N	integer. Number of runs of the screening experiment.
COLS	integer. Number of design factors.
abeta	integer. First parameter of the Beta prior distribution on model space
bbeta	integer. Second parameter of the Beta prior distribution on model space
BLKS	integer. Number of blocking factors accommodated in the first columns of matrix X.
MXFAC	integer. Maximum number of factors considered in the models.
MXINT	integer. Maximum interaction order among factors considered in the models.
NTOP	integer. Number of models to print ordered according to the highest posterior probability.
mdcnt	integer. Total number of models evaluated.
ptop	vector. Vector of posterior probabilities of the top ntop models.

`nftop`	integer. Number of factors in each of the top `ntop` models.
`jtop`	matrix. Matrix of the factors' labels of the top `ntop` models.
`prob`	vector. Vector of factor posterior probabilities.
`sigtop`	vector. Vector of residual variances of the top `ntop` models.
`ind`	integer. Indicator variable. `ind` is 1 if the '`obm`' subroutine exited properly. Any other number correspond to the format label number in the FORTRAN subroutine script.

Note

The function is a wrapper to call the FORTRAN subroutine '`obm`', modification of Daniel Meyer's original program, '`mbcqp5.f`', for the application of Objective Bayesian follow-up design.

Author(s)

Laura Deldossi. Adapted for R by Marta Nai Ruscone.

References

Consonni, G. and Deldossi, L. (2016) Objective Bayesian Model Discrimination in Follow-up design., *Test* **25**(3), 397–412. doi:10.1007/s1174901504613.

Meyer, R. D., Steinberg, D. M. and Box, G. E. P. (1996) Follow-Up Designs to Resolve Confounding in Multifactor Experiments (with discussion)., *Technometrics* **38**(4), 303–332. doi:10.2307/1271297.

See Also

`print.OBsProb`, `plot.OBsProb`, `summary.OBsProb`.

Examples

```
library(OBsMD)
data(OBsMD.es5, package="OBsMD")
X <- as.matrix(OBsMD.es5[,1:5])
y <- OBsMD.es5[,6]
# Using for model prior probability a Beta with parameters a=1 b=1
es5.OBsProb <- OBsProb(X=X,y=y, abeta=1, bbeta=1, blk=0,mFac=5,mInt=2,nTop=32)
print(es5.OBsProb)
summary(es5.OBsProb)
```

`OMD` *Objective Model Discrimination (OMD) in Follow-Up Experiments*

Description

Optimal follow-up experiments to discriminate between competing models. The extra-runs are derived from the maximization of the objective model discrimination criterion represented by a weighted average of Kullback-Leibler divergences between all possible pairs of rival models

Usage

```
OMD(OBsProb, nFac, nBlk = 0, nMod, nFoll, Xcand, mIter, nStart, startDes, top = 20)
```

Arguments

`OBsProb`	list. `OBsProb` class list. Output list of `OBsProb` function.
`nFac`	integer. Number of factors in the initial experiment.
`nBlk`	integer >=0. Number of blocking factors in the initial experiment. They are accommodated in the first columns of matrix `X`.
`nMod`	integer. Number of competing models considered to compute `OMD`.
`nFoll`	integer. Number of additional runs in the follow-up experiment.
`Xcand`	matrix. Matrix `[2^nFac x (nBlk + nFac)]` of candidate runs for the follow-up design. It generally rapresents the full `2^nFac` design.
`mIter`	integer >=0. Maximum number of iterations in the exchange algorithm. If `mIter = 0` exachange algorithm doesn't work.
`nStart`	integer. Number of different designs of dimension `nFoll` to be evaluated by `OMD` criterion. When exchange algorithm is used `nStart` represents the number of random starts to initialize the algorithm; otherwise `nStart = nrow(startDes)`.
`startDes`	matrix. Input matrix `[nStart x nFoll]` containing different `nStart` designs to be evaluated by `OMD` criterion. If the exchange algorithm is used `startDes = NULL`.
`top`	integer. Number of highest OMD follow-up designs recorded.

Details

The OMD criterion, proposed by Consonni and Deldossi, is used to discriminate among competing models. Random starting runs chosen from `Xcand` are used for the Wynn search of best OMD follow-up designs. `nStart` starting points are tried in the search limited to `mIter` iterations. If `mIter=0` then `startDes` user-provided designs are used. Posterior probabilities and residual variances of the competing models are obtained from `OBsProb`. The function calls the FORTRAN subroutine 'omd' and captures summary results. The complete output of the FORTRAN code is save in the 'MDPrint.out' file in the working directory.

Value

Below a list with all input and output parameters of the FORTRAN subroutine OMD. Most of the variable names kept to match FORTRAN code.

NSTART	integer. Number of different designs of dimension nFoll to be evaluated by OMD criterion. When exchange algorithm is used nStart represents the number of random starts to initialize the algorithm; otherwise nStart = nrow(startDes).
NRUNS	integer. Number nFoll of runs used in follow-up designs.
ITMAX	integer. Maximum number mIter of iterations in the exchange algorithm.
INITDES	integer. Indicator variable. If INITDES = 1 exachange alghoritm is used, otherwise INITDES = 0 exachange alghoritm doesn't work.
N0	integer. Numbers of runs nrow(X) of the initial experiment before follow-up.
X	matrix. Matrix from initial experiment (nrow(X); ncol(X)=nBlk+nFac).
Y	double. Response values from initial experiment (length(Y)=nrow(X)).
BL	integer >=0. The number of blocking factors in the initial experiment. They are accommodated in the first columns of matrix X and Xcand.
COLS	integer. Number of factors nFac.
N	integer. Number of candidate runs nrow(Xcand).
Xcand	matrix. Matrix [2^nFac x (nBlk + nFac)] candidate runs for the follow-up design. It generally represents the full 2^nFac design [nrow(Xcand)=N, ncol(Xcand)=ncol(X)].
NM	integer. Number of competing models nMod considered to compute OMD .
P	double. Models posterior probability optop. It derives from the OBsProb output.
SIGMA2	double. Competing models residual variances osigtop. It derives from the OBsProb output.
NF	integer. Number of main factors in each competing models onftop. It derives from the OBsProb output.
MNF	integer. Maximum number of factor in models (MNF=max(onftop)).
JFAC	matrix. Matrix ojtop of dimension [nMod x max(onftop)] of the labels of the main factors present in each competing models. It derives from the OBsProb output.
CUT	integer. Maximum order of the interaction among factors in the models mInt.
MBEST	matrix. If INITDES=0, the first row of the MBEST[1,] matrix has the first user-supplied starting design. The last row the NSTART-th user-supplied starting design.
NTOP	integer. Number of the top best OMD designs top.
TOPD	double. The OMD value for the best top NTOP designs.
TOPDES	matrix. Top NTOP optimal OMD follow-up designs.
flag	integer. Indicator = 1, if the 'md' subroutine finished properly, -1 otherwise.

Note

The function is a wrapper to call the modified FORTAN subroutine 'omd', 'OMD.f', part of the **mdopt** bundle for Bayesian model discrimination of multifactor experiments.

Author(s)

Laura Deldossi. Adapted for R by Marta Nai Ruscone.

References

Box, G. E. P. and Meyer, R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

Consonni, G. and Deldossi, L. (2016) Objective Bayesian Model Discrimination in Follow-up design., *Test* **25**(3), 397–412. doi:10.1007/s1174901504613.

Meyer, R. D., Steinberg, D. M. and Box, G. E. P. (1996) Follow-Up Designs to Resolve Confounding in Multifactor Experiments (with discussion)., *Technometrics* **38**(4), 303–332. doi:10.2307/1271297.

See Also

print.OMD, OBsProb

Examples

```
library(OBsMD)
data(OBsMD.es5, package="OBsMD")
X <- as.matrix(OBsMD.es5[,1:5])
y <- OBsMD.es5[,6]
es5.OBsProb <- OBsProb(X=X,y=y,blk=0,mFac=5,mInt=2,nTop=32)
nMod <- 26
Xcand <- matrix(c(-1,-1,-1, -1,-1,
1,-1,-1,-1,-1,
-1,1,-1,-1,-1,
1,1,-1,-1,-1,
-1,-1,1,-1,-1,
1,-1,1,-1,-1,
-1,1,1,-1,-1,
1,1,1,-1,-1,
-1,-1,-1,1,-1,
1,-1,-1,1,-1,
-1,1,-1,1,-1,
1,1,-1,1,-1,
-1,-1,1,1,-1,
1,-1,1,1,-1,
-1,1,1,1,-1,
1,1,1,1,-1,
-1,-1,-1,-1,1,
1,-1,-1,-1,1,
-1,1,-1,-1,1,
1,1,-1,-1,1,
-1,-1,1,-1,1,
1,-1,1,-1,1,
-1,1,1,-1,1,
1,1,1,-1,1,
-1,-1,-1,1,1,
1,-1,-1,1,1,
```

```
-1,1,-1,1,1,
1,1,-1,1,1,
-1,-1,1,1,1,
1,-1,1,1,1,
-1,1,1,1,1,
1,1,1,1,1
),nrow=32,ncol=5,dimnames=list(1:32,c("A","B","C","D","E")),byrow=TRUE)
p_omd <- OMD(OBsProb=es5.OBsProb,nFac=5,nBlk=0,nMod=26,nFoll=4,Xcand=Xcand,
mIter=20,nStart=25,startDes=NULL,top=30)
print(p_omd)
```

PB12Des *12-run Plackett-Burman Design Matrix*

Description

12-run Plackett-Burman design matrix.

Usage

```
data(PB12Des)
```

Format

A data frame with 12 observations on the following 11 variables.

x1 numeric vectors. Contrast factor.
x2 numeric vectors. Contrast factor.
x3 numeric vectors. Contrast factor.
x4 numeric vectors. Contrast factor.
x5 numeric vectors. Contrast factor.
x6 numeric vectors. Contrast factor.
x7 numeric vectors. Contrast factor.
x8 numeric vectors. Contrast factor.
x9 numeric vectors. Contrast factor.
x10 numeric vectors. Contrast factor.
x11 numeric vectors. Contrast factor.

References

Box G. E. P., Hunter, W. C. and Hunter, J. S. (2004) *Statistics for Experimenters II*. Wiley.

Examples

```
library(OBsMD)
data(PB12Des,package="OBsMD")
str(PB12Des)
X <- as.matrix(PB12Des)
print(t(X)%*%X)
```

plot.OBsProb *Plotting of Posterior Probabilities from Objective Bayesian Design*

Description

Method Function for plotting marginal factor posterior probabilities from Objective Bayesian Design.

Usage

```
    ## S3 method for class 'OBsProb'
plot(x, code = TRUE, prt = FALSE, cex.axis=par("cex.axis"), ...)
```

Arguments

`x`	list. List of class `OBsProb` output from the `OBsProb` function.
`code`	logical. If `TRUE` coded factor names are used.
`prt`	logical. If `TRUE`, summary of the posterior probabilities calculation is printed.
`cex.axis`	Magnification used for the axis annotation. See `par`.
`...`	additional graphical parameters passed to `plot`.

Details

A spike plot, similar to barplots, is produced with a spike for each factor. Marginal posterior probabilities are used for the vertical axis. If `code=TRUE`, `X1`, `X2`, ... are used to label the factors otherwise the original factor names are used. If `prt=TRUE`, the `print.OBsProb` function is called and the marginal posterior probabilities are displayed.

Value

The function is called for its side effects. It returns an invisible `NULL`.

Author(s)

Marta Nai Ruscone.

References

Box, G. E. P. and Meyer R. D. (1986) An Analysis of Unreplicated Fractional Factorials., *Technometrics* **28**(1), 11–18. doi:10.1080/00401706.1986.10488093.

Box, G. E. P. and Meyer, R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

Consonni, G. and Deldossi, L. (2016) Objective Bayesian Model Discrimination in Follow-up design., *Test* **25**(3), 397–412. doi:10.1007/s1174901504613.

See Also

OBsProb, print.OBsProb, summary.OBsProb.

Examples

```
library(OBsMD)
data(OBsMD.es5, package="OBsMD")
X <- as.matrix(OBsMD.es5[,1:5])
y <- OBsMD.es5[,6]
# Using for model prior probability a Beta with parameters a=1 b=1
es5.OBsProb <- OBsProb(X=X,y=y, abeta=1, bbeta=1, blk=0,mFac=5,mInt=2,nTop=32)
print(es5.OBsProb)
summary(es5.OBsProb)
plot(es5.OBsProb)
```

---

print.OBsProb — *Printing Objective Posterior Probabilities from Bayesian Design*

Description

Printing method for lists of class OBsProb. It prints the posterior probabilities of factors and models from the Objective Bayesian procedure.

Usage

```
    ## S3 method for class 'OBsProb'
print(x, X = TRUE, resp = TRUE, factors = TRUE, models = TRUE,
          nTop, digits = 3, plt = FALSE, verbose = FALSE, Sh= TRUE, CV=TRUE,...)
```

Arguments

x	list. Object of OBsProb class, output from the OBsProb function.
X	logical. If TRUE, the design matrix is printed.
resp	logical. If TRUE, the response vector is printed.
factors	logical. If TRUE, marginal posterior probabilities are printed .
models	logical. If TRUE, models posterior probabilities are printed.
nTop	integer. Number of the top ranked models to print.
digits	integer. Significant digits to use for printing.
plt	logical. If TRUE, factor marginal probabilities are plotted.
verbose	logical. If TRUE, the unclass-ed list x is displayed.
Sh	logical. If TRUE, the Shannon index is printed.
CV	logical. If TRUE, the coefficient of variation is printed.
...	additional arguments passed to print function.

Value

The function prints out marginal factors and models posterior probabilities. Returns invisible list with the components:

calc	numeric vector with general calculation information.
probabilities	Data frame with the marginal posterior factor probabilities.
models	Data frame with model posterior probabilities.
Sh	Normalized Shannon heterogeneity index on the posterior probabilities of models
CV	Coefficient of variation of factor posterior probabilities.

Author(s)

Marta Nai Ruscone.

References

Box, G. E. P. and Meyer R. D. (1986) An Analysis of Unreplicated Fractional Factorials., *Technometrics* **28**(1), 11–18. doi:10.1080/00401706.1986.10488093.

Box, G. E. P. and Meyer, R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

See Also

OBsProb, summary.OBsProb, plot.OBsProb.

Examples

```
library(OBsMD)
data(OBsMD.es5, package="OBsMD")
X <- as.matrix(OBsMD.es5[,1:5])
y <- OBsMD.es5[,6]
# Using for model prior probability a Beta with parameters a=1 b=1
es5.OBsProb <- OBsProb(X=X,y=y, abeta=1, bbeta=1, blk=0,mFac=5,mInt=2,nTop=32)
print(es5.OBsProb)
summary(es5.OBsProb)
plot(es5.OBsProb)
```

---

print.OMD *Print Optimal OMD Follow-Up Experiments*

Description

Printing method for lists of class OMD. It displays the best extra-runs according to the OMD criterion together with the correspondent OMD values.

Usage

```
## S3 method for class 'OMD'
print(x, X = FALSE, resp = FALSE, Xcand = TRUE, models = TRUE, nMod = x$nMod,
          digits = 3, verbose=FALSE, ...)
```

Arguments

`x`	list of class `OMD`. Output list of the `OMD` function.
`X`	logical. If `TRUE`, the initial design matrix is printed.
`resp`	logical If `TRUE`, the response vector of initial design is printed.
`Xcand`	logical. If `TRUE`, prints the candidate runs.
`models`	logical. Competing models are printed if `TRUE`.
`nMod`	integer. Top models to print.
`digits`	integer. Significant digits to use in the print out.
`verbose`	logical. If `TRUE`, the `unclass`-ed `x` is displayed.
`...`	additional arguments passed to `print` generic function.

Value

The function is mainly called for its side effects. Prints out the selected components of the class `OMD` objects, output of the `OMD` function. For example the marginal factors and models posterior probabilities and the top OMD follow-up experiments with their corresponding OMD statistic. It returns invisible list with the components:

`calc`	Numeric vector with basic calculation information.
`models`	Data frame with the competing models posterior probabilities.
`follow-up`	Data frame with the runs for follow-up experiments and their corresponding OMD statistic.

Author(s)

Marta Nai Ruscone.

References

Box, G. E. P. and Meyer, R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

Meyer, R. D., Steinberg, D. M. and Box, G. E. P. (1996) Follow-Up Designs to Resolve Confounding in Multifactor Experiments (with discussion)., *Technometrics* **38**(4), 303–332. doi:10.2307/1271297.

See Also

`OMD`, `OBsProb`

Examples

```
library(OBsMD)
data(OBsMD.es5, package="OBsMD")
X <- as.matrix(OBsMD.es5[,1:5])
y <- OBsMD.es5[,6]
es5.OBsProb <- OBsProb(X=X,y=y,blk=0,mFac=5,mInt=2,nTop=32)
nMod <- 26
Xcand <- matrix(c(-1,-1,-1, -1,-1,
1,-1,-1,-1,-1,
-1,1,-1,-1,-1,
1,1,-1,-1,-1,
-1,-1,1,-1,-1,
1,-1,1,-1,-1,
-1,1,1,-1,-1,
1,1,1,-1,-1,
-1,-1,-1,1,-1,
1,-1,-1,1,-1,
-1,1,-1,1,-1,
1,1,-1,1,-1,
-1,-1,1,1,-1,
1,-1,1,1,-1,
-1,1,1,1,-1,
1,1,1,1,-1,
-1,-1,-1,-1,1,
1,-1,-1,-1,1,
-1,1,-1,-1,1,
1,1,-1,-1,1,
-1,-1,1,-1,1,
1,-1,1,-1,1,
-1,1,1,-1,1,
1,1,1,-1,1,
-1,-1,-1,1,1,
1,-1,-1,1,1,
-1,1,-1,1,1,
1,1,-1,1,1,
-1,-1,1,1,1,
1,-1,1,1,1,
-1,1,1,1,1,
1,1,1,1,1
),nrow=32,ncol=5,dimnames=list(1:32,c("A","B","C","D","E")),byrow=TRUE)
p_omd <- OMD(OBsProb=es5.OBsProb,nFac=5,nBlk=0,nMod=26,
nFoll=4,Xcand=Xcand,mIter=20,nStart=25,startDes=NULL,
top=30)
print(p_omd)
```

`Reactor.data` *Reactor Experiment Data*

Description

Data of the Reactor Experiment from Box, Hunter and Hunter (1978).

Usage

```
data(Reactor.data)
```

Format

A data frame with 32 observations on the following 6 variables.

A numeric vector. Feed rate factor.

B numeric vector. Catalyst factor.

C numeric vector. Agitation rate factor.

D numeric vector. Temperature factor.

E numeric vector. Concentration factor.

y numeric vector. Percentage reacted response.

References

Box G. E. P., Hunter, W. C. and Hunter, J. S. (1978) *Statistics for Experimenters*. Wiley.

Box G. E. P., Hunter, W. C. and Hunter, J. S. (2004) *Statistics for Experimenters II*. Wiley.

Examples

```
library(OBsMD)
data(Reactor.data,package="OBsMD")
print(Reactor.data)
```

`summary.OBsProb` *Summary of Posterior Probabilities from Objective Bayesian Design*

Description

Reduced printing method for class `OBsProb` lists. Prints posterior probabilities of factors and models from Objective Bayesian procedure.

Usage

```
    ## S3 method for class 'OBsProb'
summary(object, nTop = 10, digits = 3, ...)
```

Arguments

`object`	list. `OBsProb` class list. Output list of `OBsProb` function.
`nTop`	integer. Number of the top ranked models to print.
`digits`	integer. Significant digits to use.
`...`	additional arguments passed to `summary` generic function.

Value

The function prints out the marginal factors and models posterior probabilities. Returns invisible list with the components:

`calc`	Numeric vector with basic calculation information.
`probabilities`	Data frame with the marginal posterior probabilities.
`models`	Data frame with the models posterior probabilities.

Author(s)

Marta Nai Ruscone.

References

Box, G. E. P. and Meyer R. D. (1986) An Analysis of Unreplicated Fractional Factorials., *Technometrics* **28**(1), 11–18. doi:10.1080/00401706.1986.10488093.

Box, G. E. P. and Meyer, R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

Consonni, G. and Deldossi, L. (2016) Objective Bayesian Model Discrimination in Follow-up design., *Test* **25**(3), 397–412. doi:10.1007/s1174901504613.

See Also

`OBsProb`, `print.OBsProb`, `plot.OBsProb`.

Examples

```
library(OBsMD)
data(OBsMD.es5, package="OBsMD")
X <- as.matrix(OBsMD.es5[,1:5])
y <- OBsMD.es5[,6]
# Using for model prior probability a Beta with parameters a=1 b=1
es5.OBsProb <- OBsProb(X=X,y=y, abeta=1, bbeta=1, blk=0,mFac=5,mInt=2,nTop=32)
print(es5.OBsProb)
summary(es5.OBsProb)
```

`summary.OMD` *Summary of Optimal OMD Follow-Up Experiments*

Description

Reduced printing method for lists of class `OMD`. It displays the best extra-runs according to the OMD criterion together with the correspondent OMD value.

Usage

```
    ## S3 method for class 'OMD'
summary(object, digits = 3, verbose=FALSE, ...)
```

Arguments

`object`	list of `OMD` class. Output list of `OMD` function.
`digits`	integer. Significant digits to use in the print out.
`verbose`	logical. If `TRUE`, the `unclass`-ed `object` is displayed.
`...`	additional arguments passed to `summary` generic function.

Value

It prints out the marginal factors and models posterior probabilities and the top OMD follow-up experiments with their corresponding OMD statistic.

Author(s)

Marta Nai Ruscone.

References

Box, G. E. P. and Meyer, R. D. (1993) Finding the Active Factors in Fractionated Screening Experiments., *Journal of Quality Technology* **25**(2), 94–105. doi:10.1080/00224065.1993.11979432.

Consonni, G. and Deldossi, L. (2016) Objective Bayesian Model Discrimination in Follow-up design., *Test* **25**(3), 397–412. doi:10.1007/s1174901504613.

Meyer, R. D., Steinberg, D. M. and Box, G. E. P. (1996) Follow-Up Designs to Resolve Confounding in Multifactor Experiments (with discussion)., *Technometrics* **38**(4), 303–332. doi:10.2307/1271297.

See Also

`print.OMD` and `OMD`

Examples

```
library(OBsMD)
data(OBsMD.es5, package="OBsMD")
X <- as.matrix(OBsMD.es5[,1:5])
y <- OBsMD.es5[,6]
es5.OBsProb <- OBsProb(X=X,y=y,blk=0,mFac=5,mInt=2,nTop=32)
nMod <- 26
Xcand <- matrix(c(-1,-1,-1, -1,-1,
1,-1,-1,-1,-1,
-1,1,-1,-1,-1,
1,1,-1,-1,-1,
-1,-1,1,-1,-1,
1,-1,1,-1,-1,
-1,1,1,-1,-1,
1,1,1,-1,-1,
-1,-1,-1,1,-1,
1,-1,-1,1,-1,
-1,1,-1,1,-1,
1,1,-1,1,-1,
```

```
-1,-1,1,1,-1,
1,-1,1,1,-1,
-1,1,1,1,-1,
1,1,1,1,-1,
-1,-1,-1,-1,1,
1,-1,-1,-1,1,
-1,1,-1,-1,1,
1,1,-1,-1,1,
-1,-1,1,-1,1,
1,-1,1,-1,1,
-1,1,1,-1,1,
1,1,1,-1,1,
-1,-1,-1,1,1,
1,-1,-1,1,1,
-1,1,-1,1,1,
1,1,-1,1,1,
-1,-1,1,1,1,
1,-1,1,1,1,
-1,1,1,1,1,
1,1,1,1,1
),nrow=32,ncol=5,dimnames=list(1:32,c("A","B","C","D","E")),byrow=TRUE)
p_omd <- OMD(OBsProb=es5.OBsProb,nFac=5,nBlk=0,nMod=26,
nFoll=4,Xcand=Xcand,mIter=20,nStart=25,startDes=NULL,
top=30)
summary(p_omd)
```

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