Package 'lmPerm'

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Title Permutation Tests for Linear Models

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Imports stats

Description Linear model functions using permutation tests.

License GPL (>= 2)

URL https://github.com/mtorchiano/lmPerm

Repository CRAN

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Suggests testthat

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Contents

Alfalfa   *Alfalfa Data*

Description

Alfalfa data set

Usage

```
data(Alfalfa)
```

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

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aovp   *Fitting and testing ANOVA using permutation tests*

Description

aovp is [aov](#) modified to use permutation tests instead of normal theory tests. Like aov, the ANOVA model is fitted by a call to [lmp](#) for each stratum. Timing differences between aovp and aov are negligible.

Usage

```
aovp(formula, data = NULL, perm="Exact", seqs=FALSE,
             center=TRUE, projections = FALSE, qr = TRUE,
             contrasts = NULL, ...)
```

Arguments

The arguments are the same as for [aov](#). Additional parameters may be included. They are described in the "Additional Parameters" section below. These additional parameters are the same as for [lmp](#).

formula	A formula specifying the model.
data	A data frame in which the variables specified in the formula will be found. If missing, the variables are searched for in the standard way.
perm	"Exact", "Prob", "SPR" will produce permutation probabilities. Anything else, such as "", will produce F-test probabilities.
seqs	If TRUE, will calculate sequential SS. If FALSE, unique SS.
center	If TRUE, numerical variables will be centered.
projections	Logical flag: should the projections be returned?
qr	Logical flag: should the QR decomposition be returned?
contrasts	A list of contrasts to be used for some of the factors in the formula. These are not used for any Error term, and supplying contrasts for factors only in the Error term will give a warning.
...	Arguments to be passed to aovp, such as those listed below.

Details

The model Y=Xb+Zg+e is assumed, where X is the incidence matrix for fixed effects, and Z is an incidence matrix for random effects, with columns representing the several error strata. The aovp() algorithm projects Y into strata such that each stratum has a single error term, such as a stratum defined by whole blocks. X is also projected so that the model in this stratum becomes P(Y)=P(X)bi+ei.

The vector bi is divided into sources with dfj degrees of freedom for the jth source, and summary(aovp()) will produce an ANOVA table for these sources in the ith strata. See Venables and Ripley for details.

Either permutation test p-values or the usual F-test p-values will be output. Polynomial model terms are collected into sources, so that Y~A+B+I(A^2) will contain two sources, one for A with 2 df, and one for B with 1 df. Sources for factors are treated as usual, and polynomial terms and factors may be mixed in one model. The function [poly.formula](#) may be used to create polynomial models, and the function [multResp](#) may be used to create multiresponse matrices for the lhs from variables defined in data.

The Exact method will permute the values exactly. The Prob and SPR methods will approximate the permutation distribution by randomly exchanging pairs of Y elements. The Exact method will be used by default when the number of observations is less than or equal to maxExact, otherwise Prob will be used.

Prob: Iterations terminate when the estimated standard error of the estimated proportion p is less than p*Ca. The iteration continues until all sources and coefficients meet this criterion or until maxIter is reached. See Anscome(1953) for the origin of the criterion.

SPR: This method uses sequential probability ratio tests to decide between the hypotheses p0 and p1 for a strength (alpha, beta) test. The test terminates upon the acceptance or rejection of p0 or if maxIter is reached. See Wald (1947). The power of the SPR is beta at p0 and increases to 1-beta at p1. Placing p0 and p1 close together makes the cut off sharp.

Exact: This method generates all permutations of Y. It will generally be found too time consuming for more than 10 or 11 observations, but note that aovp may be used to divide the data into small enough blocks for which exact permutation tests may be possible.

For Prob and SPR, one may set nCycle to unity to exchange all elements instead of just pairs at each iteration, but there seems to be no advantage to doing this unless the number of iterations is small – say less than 100.

The SS will be calculated *sequentially*, just as lm does; or they may be calculated *uniquely*, which means that the SS for each source is calculated conditionally on all other sources. This is SAS type III, which is also what drop1() produces, except that drop1() will not drop main effects when interactions are present. The parameter seqs may be used to override the default unique calculation behavior.

Value

The usual output from aov, with permutation p-values instead of normal theory p-values.

Iter	For Prob and SPR: The number of iterations until the criterion is met.
Accept	For SPR: 1 the p0 hypothesis is accepted, and 0 for rejection or when no decision before maxIter occurs.

Additional Parameters

These are the same as for lmp.

settings If TRUE, settings such as sequential or unique will be printed. Default TRUE

useF If TRUE, SS/Resid SS will be used, otherwise SS. The default is TRUE

maxIter For Prob and SPR: The maximum number of iterations. Default 1000.

Ca For Prob: Stop iterations when estimated standard error of the estimated p is less than Ca*p. Default 0.1

p0 For SPR: Null hypothesis probability. Default 0.05

p1 For SPR: Alternative hypothesis probability. Default 0.06

alpha For SPR: Size of SPR test. Default 0.01

beta For SPR: Type II error for SPR test. Default 0.01

maxExact For Exact: maximum number of observations allowed. If data exceeds this, Prob is used. Default 10.

nCycle For Prob and SPR: Performs a complete random permutation, instead of pairwise exchanges, every nCycle cycles. Default 1000.

Note

There is a vignette with more details and an example. To access it, type

vignette("lmPerm")

The default contrasts are set internally to (contr.sum, contr.poly), which means that coefficients are either pairwise contrasts with the last level or polynomial contrasts.

Numerical variables should be centered in order to make them orthogonal to the constant when ANOVA is to be done.

Factors with many levels may cause problems for the methodology used by R. It is designed to work well with both balanced and unbalanced data, but it is best used for factors with no more than four or five levels. If difficulties occur, degrees of freedom for high order sources will be reduced, and sometimes the sources will be omitted entirely. An error message usually accompanies such behavior.

The variables inside the `Error()` term are treated in the order given. Thus `Error(A+B)` will usually produce components in the order A,B, with B orthogonalized with respect to A. This may cause confusion for unbalanced block structures.

This function will behave identically to `aov()` if the following parameters are set: `perm=""`, `seq=TRUE, center=FALSE`.

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Hald, A. 1952 Statistical theory with engineering applications. Wiley. Table 7.4

Venables, W.N, and Ripley, B. D. (2000) Modern applied statistics with S-Plus, p176

Wald, A. (1947) Sequential analysis, Wiley, Sec. 5.3

See Also

summary.aovp, lmp

Examples

```
## A simple randomized block example.
# There are 7 blocks and 6 treatments. A first
# analysis with blocks as a factor shows block to be significant and treatments not.

data(Hald17.4)
summary(aovp(Y~T+block,Hald17.4))

# Using the block to define a separate error strata tells a different story.

summary(aovp(Y~T+Error(block),Hald17.4))

# There appears to be a linear trend in the blocks. This may be investigated by
# extracting a linear component. The factor L was created by copying the block
# factor and assigning it a linear contrast, like this
# contrasts(L,1)<-contr.poly(7). The analysis then becomes.

summary(aovp(Y~T+L+Error(block),Hald17.4))

# The L factor is not significant under permutation. It is significant when aov()
# is used and the test is the usual F-test.
```

```
## From Venables and Ripley (2000)
# This is a 2^3 factorial in the variables N,P,K. It is fractioned by using the
# three way interaction, NPK, into two fractions of 4. Each of these fractions is
# allocated to 3 blocks, making 6 blocks in all. An analysis with block as a
# variable is the following. As may be seen, aovp() discards the confounded NPK interaction.

data(NPK)
summary(aovp(yield ~ block + N*P*K, NPK))

# Since the NPK interaction was confounded with blocks, the experimenter no doubt judged
# it of lesser interest. It may however be examined by including blocks as an additional
# error term as follows. The basic error level between blocks is of course larger than
# that within blocks, so the NPK interaction would have to be substantially larger that
# it would have had to be were it tested within blocks.
summary(aovp(yield ~  N*P*K + Error(block), NPK))

# The SS calculated by aovp() are unique SS by default. That is,
# they are sums of squares for the difference of a model with and without the source. The
# resulting test is a test of the hypothesis that the source has no effect on the response.
# Sequential SS, which are those produced by aov() may be obtained by setting the
# parameter seqs=TRUE. simDesign is an unbalanced design created by the AlgDesign package.

data(simDesign)
summary(aovp(Y~.,simDesign))
summary(aovp(Y~.,simDesign,seqs=TRUE))

# Since there is only one stratum, these results are the same as would be obtained from
anova(lmp(Y~.,simDesign))

# ANOVA for numerical variables. First using contrasts, then numeric variables.
data(Federer276)
summary(aovp(Plants~Variety*Treatment+Error(Rep/Plot),Federer276))
data(Federer276Numeric)
summary(aovp(poly.formula(Plants~quad(Variety,Treatment)+Error(Rep/Plot)),Federer276Numeric))
# The coefficients and their p-values may be obtained by
summaryC(aovp(Plants~Variety*Treatment+Error(Rep/Plot),Federer276))
```

CC164   *Cochran and Cox, p164*

Description

Factorial Experiment

Usage

```
data(CC164)
```

Details

A three factor experiment involving lettuce plants. Response is the number of lettuce plants emerging after treatment by three levels of either nitrogen or phospate fertilizer.

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Chochran, W. and Cox, G. (1957). Experimental Design, 2nd Ed. John Wiley & Sons, New York.

---

composite	*Test of theroplastic composite*

Description

Data from a factorial experiment.

Usage

```
data(composite)
```

Details

A two variable factorial experiment to test the strength of a thermoplastic composite to laser intensity and tape speed.

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Faraway, J. (2005). Linear Models with R. Chapman and Hall. N.Y.

Federer276   *Federer 276*

Description

Randomized block in three replicates

Usage

    data(Federer276)

Details

A seed-gemination test on eight varieties of guayule. Four treatments were applied to lots of seed from the varieties.

A split plot design assigning varieties to whole plots was used. Treatments formed randomized blocks within whole plots. There were three replicates.

The whole plots were nested within replicates

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Federer, W.T. (1955). Experimental Design, Macmillan, N.Y.

Federer276Numeric   *Federer 276 Numeric*

Description

Randomized block in three replicates

Usage

    data(Federer276)

Details

Varieties and Treatments are numeric variables.

A seed-gemination test on eight varieties of guayule. Four treatments were applied to lots of seed from the varieties.

A split plot design assigning varieties to whole plots was used. Treatments formed randomized blocks within whole plots. There were three replicates.

The whole plots were nested within replicates

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Federer, W.T. (1955). Experimental Design, Macmillan, N.Y.

---

ghoctane   *Octane blends*

Description

Gasoline blending mixture experiment

Usage

```
data(ghoctane)
```

Details

An octane-blending experiment for a ternary system. Motor-octane ratings were obtained for a seven lattice point design, and two checkpoints.

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Gorman, J.W. and Hinman, J.E. (1962). Simples lattice designs for multicomponent systems. Technometics. 4-4. 463-487. John Wiley & Sons, New York.

Hald17.4   *Hald Data*

Description

Data from Hald Table 17.4 on p 505.

Usage

```
data(Hald17.4)
```

Details

A randomized block experiment with 7 blocks and 6 treatments.

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Hald, A. (1952). Statistical theory with engineering applications. Wiley. NY.

---

lmp   *Fitting and testing linear models with permutation tests.*

Description

lmp is [lm](#) modified to use permutation tests instead of normal theory tests. Like lm, it can be used to carry out regression, single stratum analysis of variance and analysis of covariance . Timing differences between lmp and lm are negligible.

Usage

```
lmp(formula, data, perm="Exact", seqs=FALSE, center=TRUE, subset, weights, na.action,
method = "qr", model = TRUE, x = FALSE, y = FALSE, qr = TRUE,
    singular.ok = TRUE, contrasts = NULL, offset, ...)
```

Arguments

The arguments are mostly the same as for [lm](#). Additional parameters may be included. They are described in the "Additional Parameters" section below. These additional parameters are the same as for [aovp](#).

formula	a symbolic description of the model to be fit.
data	an optional data frame containing the variables in the model. If not found in data, the variables are taken from environment(formula), typically the environment from which lmp is called.
perm	"Exact", "Prob", "SPR" will produce permutation probabilities. Anyting else, such as "", will produce F-test probabilites.
seqs	If TRUE, will calculate sequential SS. If FALSE, unique SS.
center	If TRUE will center numerical variables
subset	an optional vector specifying a subset of observations to be used in the fitting process.
weights	an optional vector of weights to be used in the fitting process. If specified, weighted least squares is used with weights weights (that is, minimizing sum(w*e^2)); otherwise ordinary least squares is used.
na.action	a function which indicates what should happen when the data contain NAs. The default is set by the na.action setting of [options](#), and is [na.fail](#) if that is unset. The "factory-fresh" default is [na.omit](#). Another possible value is NULL, no action. Value [na.exclude](#) can be useful.

method	the method to be used; for fitting, currently only method = "qr" is supported; method = "model.frame" returns the model frame (the same as with model = TRUE, see below).
model, x, y, qr	logicals. If TRUE the corresponding components of the fit (the model frame, the model matrix, the response, the QR decomposition) are returned.
singular.ok	logical. If FALSE (the default in S but not in R) a singular fit is an error.
contrasts	an optional list. See the contrasts.arg of model.matrix.default.
offset	this can be used to specify an *a priori* known component to be included in the linear predictor during fitting. An offset term can be included in the formula instead or as well, and if both are specified their sum is used.
...	additional arguments to be passed.

Details

The usual regression model EY=Xb is assumed. The vector b is divided into sources with dfi degrees of freedom for the ith source, and anova(lmp()) will produce an ANOVA table for these sources. Either permutation test p-values or the usual F-test p-values will be output. Polynomial model terms are collected into sources, so that Y~A+B+I(A^2) will contain two sources, one for A with 2 df, and one for B with 1 df. Sources for factors are treated as usual, and polynomial terms and factors may be mixed in one model. The function poly.formula may be used to create polynomial models, and the function multResp may be used to create a multi-response matrix for the lhs from variables in data.

One may also use summary(lm()) to obtain coefficient estimates and estimates of the permutation test p-values. The Exact method will permute the values exactly. The Prob and SPR methods will approximate the permutation distribution by randomly exchanging pairs of Y elements. The Exact method will be used by default when the number of observations is less than or equal to maxExact, otherwise Prob will be used.

Prob: Iterations terminate when the estimated standard error of the estimated proportion p is less than p*Ca. The iteration continues until all sources and coefficients meet this criterion or until maxIter is reached. See Anscome(1953) for the origin of the criterion.

SPR: This method uses sequential probability ratio tests to decide between the hypotheses p0 and p1 for a strength (alpha, beta) test. The test terminates upon the acceptance or rejection of p0 or if maxIter is reached. See Wald (1947). The power of the SPR is beta at p0 and increases to 1-beta at p1. Placing p0 and p1 close together makes the cut off sharp.

Exact: This method generates all permutations of Y. It will generally be found too time consuming for more than 10 or 11 observations, but note that aovp may be used to divide the data into small enough blocks for which exact permutation tests may be possible.

For Prob and SPR, one may set nCycle to unity to exchange all elements instead of just pairs at each iteration, but there seems to be no advantage to doing this unless the number of iterations is small – say less than 100.

The SS will be calculated *sequentially*, just as lm() does; or they may be calculated *uniquely*, which means that the SS for each source is calculated conditionally on all other sources. This is SAS type III, which is also what drop1() produces, except that drop1() will not drop main effects when interactions are present. The parameter seqs may be used to override the default unique calculation behavior.

Value

The usual output from [lm](), with permutation p-values or F-test p-values. The p-values for the coefficients are of necessity, two-sided.

Iter   For Prob and SPR: The number of iterations until the criterion is met.

Accept   For SPR: 1 the p0 hypothesis is accepted, and 0 for rejection or when no decision
              before maxIter occurs.

Additional parameters

These are the same as for [aovp]().

settings If TRUE, settings such as sequential or unique will be printed. Default TRUE

useF If TRUE, SS/Resid SS will be used, otherwise SS. The default is TRUE

maxIter For Prob and SPR: The maximum number of iterations. Default 1000.

Ca For Prob: Stop iterations when estimated standard error of the estimated p is less than Ca*p.
     Default 0.1

p0 For SPR: Null hypothesis probability. Default 0.05

p1 For SPR: Alternative hypothesis probability. Default 0.06

alpha For SPR: Size of SPR test. Default 0.01

beta For SPR: Type II error for SPR test. Default 0.01

maxExact For Exact: maximum number of observations allowed. If data exceeds this, Prob is
     used. Default 10.

nCycle For Prob and SPR: Performs a complete random permutation, instead of pairwise exchanges, every nCycle cycles. Default 1000.

Note

There is a vignette with more details and an example. To access it, type

vignette("lmPerm")

The default contrasts are set internally to (contr.sum, contr.poly), which means that factor coefficients are either pairwise contrasts with the last level or polynomial contrasts.

Numerical variables should be centered in order to make them orthogonal to the constant when ANOVA is to be done.

This function will behave identically to lm() if the following parameters are set: perm="", seq=TRUE, center=FALSE. An exception for multiple responses is that an ANOVA table for each response is output instead of a call to anova.mlm().

Author(s)

Bob Wheeler <rwheeler@echip.com>

References

Chochran, W. and Cox, G. (1957) p164 Experimental Design, 2nd Ed. John Wiley & Sons, New York.

Wald, A. (1947) Sequential analysis, Wiley, Sec. 5.3

Quinlan, J. (1985) "Product improvement by application of Taguchi methods." in American Supplier Institute News (special symposium ed.) Dearborn, MI. American Supplier Institute. 11-16.

Box, G. (1988) Signal-to-noise ratios, performance criteria, and transformations. Technometics. 30-1. 1-17.

See Also

summary.lmp, aovp

Examples

```
# 3x3 factorial with ordered factors, each is average of 12.
# This is a saturated design with no df for error. The results tend to support
# Cochran and Cox who used a guessed residual SS for their analysis. The design
# is balanced, so the sequential SS are the same as the unique SS.
data(CC164)
summary(lmp(y ~ N * P, data = CC164, perm="")) # F-value output as if lm() was used.
summary(lmp(y ~ N * P, data = CC164,)) # Default, using "Exact" if possible.
summary(lmp(y ~ N * P, data = CC164, perm="SPR"))
anova(lmp(y ~ N * P, data = CC164))

# A two level factorial. The artificial data is N(0,1) with an effect of
# 1.5 added to factor X4. When the number of iterations are small, as in
# this case, using nCycle=1 is advantageous.
X<-expand.grid(X1=1:2,X2=1:2,X3=1:2,X4=1:2)
X$Y<-c(0.99,1.34,0.88,1.94,0.63,0.29,-0.78,-0.89,0.43,-0.03,0.50,1.66,1.65,1.78,1.31,1.51)
summary(lmp(Y~(X1+X2+X3+X4)^2,X,"SP"))  # The prob method is used because "SP" is not recognized.
summary(lmp(Y~(X1+X2+X3+X4)^2,X,"SPR"))
summary(lmp(Y~(X1+X2+X3+X4)^2,X,"SPR",nCycle=1)) #An additional parameter being passed.

# A saturated design with 15 variables in 16 runs. The orginal analysis by Quinlan pooled the mean
# squares from the 7 smallest effcts and found many variables to be significant. Box, reanalyzed
# the data using half-normal plots and found only variables E and G to be important. The permutation
# analysis agrees with this conclusion.
data(Quinlan)
summary(lmp(SN~.,Quinlan))

# A design containing both a polynomial variable and a factor
data(simDesignPartNumeric)
anova(lmp(poly.formula(Y~quad(A,B)+C),simDesignPartNumeric))
```

---

manly126   *Manly, p126*

Description

Lizard data

Usage

```
data(manly126)
```

Details

Two factor data showing ant consumption by lizards. In addition, three aditional columns, v1,v2,v3, are included representing the additions used by Manly to calculate power.

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Manly, B.F.J. (1998). Randomization, bootstrap and Monte Carlo methods in Biology. 2nd Ed. Chapman & Hall, London.

---

manly136   *Non normal Ephemeroptera counts*

Description

Ephemeroptera counts from New Zealand streams.

Usage

```
data(manly136)
```

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Manly, B.F. (1998). Randomization, bootstrap and monte carlo methods in biology. Chapman and Hall, NY.

---

multResp   *Multple response creation*

Description

This function creates a multiple response matrix for its argument variables. When used on the lhs of the formula in lmp() or aovp() it will create a matrix containing one or more response columns from variables defined in the data argument.

Usage

```
multResp(...)
```

Arguments

...   Variable names separated by commas.

Value

A matrix with named columns

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

Please cite this program as follows:

Wheeler, R.E. (2010). multResp() *lmPerm*. The R project for statistical computing https://www.r-project.org

Examples

```
A<-1:5
B<-1:5
multResp(A,B)

data(Plasma)
anova(lmp(multResp(Amin,Pct,sinpoly)~.,Plasma))
```

NPK   *NPK Data*

Description

Data from Venables and Ripley, Table 6.1, p176.

Usage

```
data(NPK)
```

Details

A fractional factorial with blocks confounded with the three way interaction.

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Venables, W.N. and Ripley, B.D. (2000) Modern applied statistics with S-Plus. 3rd ed. Springer, NY.

---

permute   *Permutation Generation*

Description

Generates permutations a pair at a time.

Usage

```
permute(N=4,K=1,initialize=0)
```

Arguments

N	The number of elements in the permutation vector. The elements are numbered 1:N
K	The number of exchange pairs to be returned at each access
initialize	Set to 1 to initialize. Set to 0 for additional pairs.

Details

On first call, set initialize to 1. On subsequent accesses, initialize should be 0. The function returns at most K exchange pairs at each access. The function should be repeatedly called until result is false.

The function returns a list.

Value

result   Returns false when the last permutation has been generated or a failure has occurred. Returns true for success and at most K new pairs in vec.

N   The input parameter

K   The input parameter

vec   A 2*K vector of element numbers to be exchanged – permutations may be obtained by successively applying these pairs.

initialize   Always returns 1

count   The number of pairs in vec. It may be less than K for the final set.

Note

This is the minimum time and effort routine. It is used for Exact permutation calculations. The present function is a wrapper for the C code and may be useful for other purposes. The code follows Reingole and Nievergelt (1977).

Author(s)

Bob Wheeler <rwheeler@echip.com>

References

Reingold, E.M., Nievergelt, J., and Deo, N. (1977) Combinatorial Algorithms Theory and Practice. Prentice Hall, New Jersey. p170.

Plasma   *Plasma Etching*

Description

An experiment designed to guide optimization of a nitride etch process

Usage

```
data(Plasma)
```

Details

An orthogonal arry, capable of supporting a linear model only. The factors are denoted by their
units of measurement. They were W, the power applied to the cathode; mTorr, the pressure in the
reaction chamber; cm, gap between anode and cathode; sscm, flow if the reactant gas. The three
responses: Amin, etch rate; Pct, unifomity; sinpoly, selectivity.

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Vardeman, Stephen B. (1994).Statistics for engineering problem solving. PWS publishing Co.
Boston. p 596

---

poly.formula   *Makes a polynomial model*

Description

Formulas are expanded to accommodate special functions for continuous and mixture variables.

Usage

```
poly.formula(frml)
```

Arguments

frml   A formula using ~ in the usual way.

Details

This function expands formulas to accommodate polynomial models for which R has minimal sup-
port. Assuming for illustration that there are three variables, A, B, and C, the following expressions
may be used.

All agruments to quad(), cubic(), and cubicS() must be numeric.

- quad(A,B,C) makes $(A + B + C)^2 + I(A^2) + I(B^2) + I(C^2)$
- cubic(A,B,C) makes $(A + B + C)^3 + I(A^2) + I(B^2) + I(C^2) + I(A^3) + I(B^3) + I(C^3)$
- cubicS(A,B,C) makes $(A+B+C)^3 + I(A*B*(A-B)) + I(A*C*(A-C)) + I(B*C*(B-C))$

The cubicS() function produces a non-singular representation of a cubic model, when the variables
are mixture variables, that is when the rows of data sum to a constant value, usually 1.0. Because
of the mixture constraint, models containing mixture variables should not have a constant term. The
linear and quadratic models for mixture variables A, B, and C are given by $-1 + (A + B + C)$ and
$-1 + (A + B + C)^2$ respectively. See Gorman and Hinman [1962] for details.

Value

An expanded formula is returned.

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

Please cite this program as follows:

Wheeler, R.E. (2010). poly.formula *lmPerm*. The R project for statistical computing https://www.r-project.org

References

Gorman, J.W. and Hinman, J.E. (1962). Simplex lattice designs for multicomponent systems. *Technometrics*. 4-4. 463-487.

Examples

```
poly.formula(y~quad(A,B,C)+Error(block))
```

Quinlan	*Quinlan's data*

Description

Data from a Symposium on Taguchi Methods, analyzed by G.E.P. Box

Usage

```
data(Quinlan)
```

Details

A saturated design: L16 in Taguchi termonology, but just a $2^{(15-11)}$III design using the symbolism in Box (1978). Reanalyzed by Box (1988).

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Quinlan, J. (1985) "Product improvement by application of Taguchi methods." in American Supplier Institute News (special symposium ed.) Dearborn, MI. American Supplier Institute. 11-16.

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

Box, G. (1988) Signal-to-noise ratios, performance criteria, and transformations. Technometics. 30-1. 1-17.

---

ratGenotype   *ratGenotype Data*

Description

Data from Scheffe, p140

Usage

```
data(ratGenotype)
```

Details

An unbalanced design. The data originally appeared in Bailey (1953), and was reproduced in Scheffe (1959) with the description:

"...gives the weight of hybrid female rats in a foster-nursing experiment with four types of rats. (The weights are litter averges in grams at 28 days. The within litter variance was obviously negligible compared to the between-litter variance.) The factors in the two-way laout are the genotype of the foster mother and that of the litter. "

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Scheffe, H. (1959) The Analysis of Variance, Wiley, NY.

Bailey, D.W. (1953) "The inheritance of Maternal Influences on the Growth of the Rat". Ph.D. thesis, Univ. California

---

simDesign   *A non-orthogonal design*

Description

A three factor design created using AlgDesign, with a normal response.

Usage

```
data(simDesign)
```

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

---

simDesignPartNumeric   *A non-orthogonal design*

Description

A three factor design created using AlgDesign, with a normal response.

Usage

```
data(simDesignPartNumeric)
```

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

---

summary   *Summarizing functions for linear models*

Description

Replaces corresponding functions in base package.

Usage

```
## S3 method for class 'lmp'
summary(object, correlation = FALSE, symbolic.cor = FALSE, ...)
## S3 method for class 'mlmp'
summary(object, ...)
## S3 method for class 'summary.lmp'
print(x, digits = max(3, getOption("digits") - 3),
               symbolic.cor = x$symbolic.cor,
      signif.stars= getOption("show.signif.stars"),...)
## S3 method for class 'aovp'
summary(object, intercept = FALSE, split,
                         expand.split = TRUE, keep.zero.df = TRUE, ...)
## S3 method for class 'lmp'
anova(object, ...)
```

Arguments

Same as for the corresponding functions in base package:

object	an object of class "lm", usually, a result of a call to [lm](#).
x	an object of class "summary.lm", usually, a result of a call to summary.lm.

correlation	logical; if TRUE, the correlation matrix of the estimated parameters is returned and printed.
digits	the number of significant digits to use when printing.
symbolic.cor	logical. If TRUE, print the correlations in a symbolic form (see [symnum](#)) rather than as numbers.
signif.stars	logical. If TRUE, "significance stars" are printed for each coefficient.
intercept	logical: should intercept terms be included?
split	an optional named list, with names corresponding to terms in the model. Each component is itself a list with integer components giving contrasts whose contributions are to be summed.
expand.split	logical: should the split apply also to interactions involving the factor?
keep.zero.df	logical: should terms with no degrees of freedom be included?
...	further arguments passed to or from other methods.

Details

These modified functions are needed because the perm values, which are attached to the object, replace the usual test columns in the output from these functions.

Author(s)

Bob Wheeler <rwheeler@echip.com>

---

summaryC   *Coefficient summary from aovp*

Description

Summarize an analysis of variance model showing coefficients

Usage

```
## S3 method for class 'aovlist':
summaryC(object, ...)
```

Arguments

object	an object of class aovlist
...	further arguments passed on.

Details

Summarizes aovp output in terms of coefficients with p-values.

Author(s)

Bob Wheeler <rwheeler@echip.com>

Examples

```
data(Alfalfa)
summaryC(aovp(Yield~Variety*Date+Error(Block/Variety),Alfalfa))
```

---

wool	*wool data*

Description

A three factor experiment with non-normal response

Usage

```
data(wool)
```

Details

There are three, 3-level factors:

len length of test specimen in mm

amp amplitude of loading cycle in mm

load the load in g

The response was the number of cycles to failure of worsted yarn under cycles of repeated loading

Author(s)

Bob Wheeler <bwheelerg@gmail.com>

References

Box, G.E.P. and Cox, D.R. (1964) An analysis of transformations (with discussion). J.R. Statists. Soc. B. 26. 211-246.

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