# Package 'asremlPlus'

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**Version** 4.1-36

**Date** 2020-01-12

**Title** Augments 'ASReml-R' in Fitting Mixed Models and Packages
Generally in Exploring Prediction Differences

**Depends** R (>= 3.1.0)

**Imports** dae, ggplot2, stats, methods, utils, reshape, plyr, dplyr,
stringr, RColorBrewer, grDevices, foreach, parallel, doParallel

**Suggests** testthat, lattice, emmeans, lmerTest, pbkrtest, R.rsp

**Enhances** asreml

**VignetteBuilder** R.rsp

**SystemRequirements** asreml-R 2.x

**Description** Assists in automating the testing of terms in mixed models when 'asreml' is
used to fit the models. Also used to display, in tables and graphs, predictions obtained
using any model fitting function and to explore differences between predictions.
The content falls into the following natural groupings: (i) Data, (ii) Object
manipulation functions, (iii) Model modification functions, (iv) Model testing functions,
(v) Model diagnostics functions, (vi) Prediction production and presentation functions,
(vii) Response transformation functions, and (viii) Miscellaneous functions. A history of
the fitting of a sequence of models is kept in a data frame. Procedures are available for
choosing models that conform to the hierarchy or marginality principle and for displaying
predictions for significant terms in tables and graphs. The 'asreml' package provides a
computationally efficient algorithm for fitting mixed models using Residual Maximum
Likelihood. It is a commercial packages that can be purchased from
'VSNi' <http://www.vsni.co.uk/> as 'asreml-R', who will supply a zip file for local
installation/updating. It is not needed for functions that are methods for 'alldiffs'
and 'data.frame' objects. The package 'asremPlus' can also be installed from
<http://chris.brien.name/rpackages/>.

**License** MIT + file LICENSE

**URL** <http://chris.brien.name>

**NeedsCompilation** no

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# R **topics documented:**

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asremlPlus-package    *Augments 'ASReml-R' in Fitting Mixed Models and Packages Generally in Exploring Prediction Differences*

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## Description

Assists in automating the testing of terms in mixed models when 'asreml' is used to fit the models. Also used to display, in tables and graphs, predictions obtained using any model fitting function and to explore differences between predictions. The content falls into the following natural groupings: (i) Data, (ii) Object manipulation functions, (iii) Model modification functions, (iv) Model testing functions, (v) Model diagnostics functions, (vi) Prediction production and presentation functions, (vii) Response transformation functions, and (viii) Miscellaneous functions. A history of the fitting of a sequence of models is kept in a data frame. Procedures are available for choosing models that conform to the hierarchy or marginality principle and for displaying predictions for significant terms in tables and graphs. The 'asreml' package provides a computationally efficient algorithm for fitting mixed models using Residual Maximum Likelihood. It is a commercial packages that can be purchased from 'VSNi' <http://www.vsni.co.uk/> as 'asreml-R', who will supply a zip file for local installation/updating. It is not needed for functions that are methods for 'alldiffs' and 'data.frame' objects. The package 'asremPlus' can also be installed from <http://chris.brien.name/rpackages/>.

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## Index

(i) Data

| Wheat.dat | Data for an experiment to investigate 25 varieties of wheat. |
| WaterRunoff.dat | Data for an experiment to investigate the quality of water runoff over time |

(ii) Object manipulation

| as.alldiffs | Forms an `alldiffs.object` from the supplied predictions, along with those statistics, associated with the predictions and their pairwise differnces, that have been supplied. |
| asrtests | Pseudonym for `as.asrtests`. |
| as.asrtests | Forms an `asrtests.object` that stores (i) a fitted asreml object, (ii) a pseudo-anova table for the fixed terms and (iii) a history of changes and hypthesis testing used in obtaining the model. |
| as.predictions.frame | Forms a `predictions.frame` from a data.frame, ensuring that the correct columns are present. |
| facCombine.alldiffs | Combines several factors into one in the components of an `alldiffs.object`. |
| facRecode.alldiffs | Recodes factor levels using values in a vector. The values in the vector do not have to be unique. |
| facRename.alldiffs | Renames `factor`s in the `prediction` component of an `alldiffs.object`. |
| is.alldiffs | A single-line function that tests whether an object is of class alldiffs. |
| is.asrtests | A single-line function that tests whether an object is of class asrtests. |
| is.predictions.frame | A single-line function that tests whether an object is of classes `predictions.frame` and `data.frame`. |
| print.alldiffs | Prints the values in an `alldiffs.object` in a nice format. |
| print.asrtests | Prints the values in an `asrtests.object`. |
| print.predictions.frame | Prints the values in a `predictions.frame`, with or without title and heading |
| print.wald.tab | Prints a Wald or pseudoanova table. |
| sort.alldiffs | Sorts the components of an `alldiffs.object` according to the predicted values associated with a factor. |
| subset.alldiffs | Subsets the components in an `alldiffs.object` according to the supplied condition. |
| validAlldiffs | Checks that an object is a valid `alldiffs.object`. |
| validAsrtests | Checks that an object is a valid `asrtests.object`. |
| validPredictionsFrame | Checks that an object is a valid `predictions.frame`. |

(iii) Model modification

| changeTerms.asrtests | Adds and drops the specified sets of terms from one or both of the fixed or random model and/or replaces the residual (rcov) model with a new model. |
| newfit.asreml | Refits an asreml model with modified model formula using either a call to 'update.asreml' or a direct call to 'asreml'. |
| reparamSigDevn.asrtests | Reparamterizes each random (deviations) term involving 'devn.fac' to a fixed term and ensures that the same term, with 'trend.num' replacing 'devn.fac', is included if any other term with 'trend.num' is included in 'terms'. |
| rmboundary.asrtests | Removes any boundary or singular variance components from the fit stored in 'asreml.obj' and records their removal in an `asrtests.object`. |
| setvarianceterms.call | Allows the setting of bounds and initial values for terms in the 'random' and 'residual' arguments of an |

'asreml' call.

(iv) Model testing

| | |
|---|---|
| chooseModel.asrtests | Determines the set of significant terms taking into account hierarchy or marginality relations and records the tests performed in an asrtests.object. |
| getTestPvalue.asrtests | Gets the p-value for a test recorded in the test.summary data.frame of an asrtests.object. |
| infoCriteria.asreml | Computes AIC and BIC for a model. |
| recalcWaldTab.asrtests | Recalculates the denDF, F.inc and P values for a table of Wald test statistics obtained using 'wald.asreml'. |
| REMLRT.asreml | Performs a REML ratio test. |
| bootREMLRT.asreml | Performs a REML ratio test using the parametric bootstrap. |
| testranfix.asrtests | Tests for a single fixed or random term in model fitted using 'asreml' and records the result in an asrtests.object. |
| testresidual.asrtests | Fits a new residual formula using 'asreml', tests whether the change is significant and records the result in an asrtests.object. |
| testswapran.asrtests | Tests, using a REMLRT, the significance of the difference between the current random model and one in which oldterms are dropped and newterms are added. The result is recorded in an asrtests.object. |

(v) Model diagnostics and simulation

| | |
|---|---|
| plotVariofaces | Plots empirical variogram faces, including envelopes, from supplied residuals as described by Stefanova, Smith & Cullis (2009). |
| variofaces.asreml | Calculates and plots empirical variogram faces, including envelopes, as described by Stefanova, Smith & Cullis (2009). |
| estimateV.asreml | Forms the estimated variance, random or residual matrix for the observations from the variance parameter estimates. |
| simulate.asreml | Produce sets of simulated data from a multivariate normal distribtion and save quantites related to the simulated data. |

(vi) Prediction production and presentation

| | |
|---|---|
| addBacktransforms.alldiffs | Adds or recalculates the backtransforms component of an alldiffs.object. |
| allDifferences.data.frame | Using supplied predictions and standard errors of pairwise differences or the variance matrix of predictions, forms all pairwise differences between the set of predictions, and p-values for the differences. |
| linTransform.alldiffs | Calculates a linear transformation of the predictions stored in an alldiffs.object. |
| plotPredictions.data.frame | Plots the predictions for a term, possibly with error bars. |
| plotPvalues.alldiffs | Plots the p-values in the p.differences components of an alldiffs.object as a heat map. |

| | |
|---|---|
| plotPvalues.data.frame | Plots the p-values in data.frame as a heat map. |
| predictPlus.asreml | Forms the predictions and associated statistics for a term, using an asreml object and a wald.tab and taking into account that a numeric vector and a factor having parallel values may occur in the model. It stores the results in an object of class 'alldifffs' and may print the results. It can be when there are not parallel values. |
| predictPresent.asreml | Forms the predictions for each of one or more terms and presents them in tables and/or graphs. |
| recalcLSD.alldiffs | Adds or recalculates the LSD component of an alldiffs.object. |
| redoErrorIntervals.alldiffs | Adds or replaces the error intervals stored in the prediction component of an alldiffs.object. |
| renewClassify.alldiffs | Renews the components in an alldiffs.object according to a new classify. |
| sort.alldiffs | Sorts the components in an alldiffs.object according to the predicted values associated with a factor. |
| subset.alldiffs | Subsets the components in an alldiffs.object according to the supplied condition. |

(vii) Response transformation

| | |
|---|---|
| angular | Applies the angular transformation to proportions. |
| angular.mod | Applies the modified angular transformation to a vector of counts. |
| powerTransform | Performs a combination of a linear and a power transformation on a variable. The transformed variable is stored in the 'data.frame data'. |

(viii) Miscellaneous

| | |
|---|---|
| getASRemlVersionLoaded | Finds the version of asreml that is loaded and returns the initial characters in version. |
| loadASRemlVersion | Ensures that a specific version of asreml is loaded. |
| num.recode | Recodes the unique values of a vector using the values in a new vector. |
| permute.square | Permutes the rows and columns of a square matrix. |
| permute.to.zero.lowertri | Permutes a square matrix until all the lower triangular elements are zero. |

The functions whose names end in 'alldiffs" utilize an alldiffs.object that stores: (i) a predictions.frame, being a data frame containing predicted values, variables indexing them and their standard errores and estimability status; the lower and upper limits of error intervals will be included when these are requested, (ii) optionally, square matrices containing all pairwise differences, the standard errors and p-values of the differences, and a summary of the LSD values, (iii) optionally, the variance matrix of the predictions, and (iv) if the response was trandformed for analysis, a data frame with backtransforms of the predicted values.

The functions whose names end in 'asrtests', which are most of the model functions, utilize an asrtests.object that stores: (i) the currently fitted model in asreml.obj, (ii) the table of test statistics for the fixed effects in wald.tab, and (iii) a data frame that contains a history of the

changes made to the model in `test.summary`.

## Author(s)

NA

Maintainer: NA

## References

Butler, D. G., Cullis, B. R., Gilmour, A. R., Gogel, B. J. and Thompson, R. (2018). *ASReml-R Reference Manual Version 4.* VSN International Ltd, http://asreml.org.

Stefanova, K. T., Smith, A. B. & Cullis, B. R. (2009) Enhanced diagnostics for the spatial analysis of field trials. *Journal of Agricultural, Biological, and Environmental Statistics*, **14**, 392–410.

## See Also

`asreml`

## Examples

```
## Not run:
## Analyse wheat dat using asreml and asremlPlus (see also the Wheat Vignette)
## Set up for analysis
library(dae)
library(asreml)
library(asremlPlus)
## use ?Wheat.dat for data set details
data(Wheat.dat)

# Fit initial model
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
summary(current.asr)

# Intialize a testing sequence by loading the current fit into an asrtests object
current.asrt <- as.asrtests(current.asr, NULL, NULL)

# Check for and remove any boundary terms
current.asrt <- rmboundary(current.asrt)

#Unbind Rep, Row and Column components and reload into an asrtests object
current.asr <- setvarianceterms(current.asr$call,
                                terms = c("Rep", "Rep:Row", "Rep:Column"),
                                bounds = "U")
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary(current.asrt)
summary(current.asrt$asreml.obj)$varcomp
print(current.asrt, which = "testsummary")
print(current.asrt, which = "pseudoanova")

# Check term for within Column pairs (a post hoc covariate)
current.asrt <- testranfix(current.asrt, "WithinColPairs", drop.fix.ns=TRUE)

# Test nugget term
```

```
current.asrt <- testranfix(current.asrt, "units", positive=TRUE)

# Test Row autocorrelation
current.asrt <- testresidual(current.asrt, "~ Row:ar1(Column)",
                             label="Row autocorrelation", simpler=TRUE)

# Test Col autocorrelation (depends on whether Row autocorrelation retained)
(p <- getTestPvalue(current.asrt, label = "Row autocorrelation"))
{ if (p <= 0.05)
    current.asrt <- testresidual(current.asrt, "~ ar1(Row):Column",
                                 label="Col autocorrelation",
                                 simpler=TRUE, update=FALSE)
  else
    current.asrt <- testresidual(current.asrt, "~ Row:Column",
                                 label="Col autocorrelation",
                                 simpler=TRUE, update=FALSE)
}

# Output the results
print(current.asrt, which = "test")
info <- infoCriteria(current.asrt$asreml.obj)
summary(current.asrt$asreml.obj)$varcomp

# Get current fitted asreml object and update to include standardized residuals
current.asr <- current.asrt$asreml.obj
current.asr <- update(current.asr, aom=TRUE)
Wheat.dat$res <- residuals(current.asr, type = "stdCond")
Wheat.dat$fit <- fitted(current.asr)

#### Do diagnostic checking
# Do residuals-versus-fitted values plot
with(Wheat.dat, plot(fit, res))

#Produce variogram and variogram faces plot (Stefanaova et al, 2009)
plot.varioGram(varioGram(current.asr))
faces <- variofaces(current.asr, V=NULL, units="addtores",
                    maxiter=50, update = FALSE)

#Get Variety predictions, sorted in increasing order for the predicted values,
#and all pairwise prediction differences and p-values
Var.diffs <- predictPlus(classify = "Variety",
                         asreml.obj=current.asr,
                         error.intervals="halfLeast",
                         wald.tab=current.asrt$wald.tab,
                         sortFactor = "Variety",
                         tables = "predictions")
print(Var.diffs, which = c("differences", "p.differences"))

# Plot the Variety predictions, with halfLSD intervals, and the p-values
plotPredictions(Var.diffs$predictions,
                classify = "Variety", y = "predicted.value",
                error.intervals = "half")
plotPvalues(Var.diffs)

## End(Not run)
```

addBacktransforms.alldiffs

> *Adds or recalculates the backtransforms component of an* alldiffs.object.

#### Description

Given an alldiffs.object, adds or recalculate its backtransforms component.

#### Usage

```
## S3 method for class 'alldiffs'
addBacktransforms(alldiffs.obj, transform.power = 1,
                  offset = 0, scale = 1, ...)
```

#### Arguments

alldiffs.obj     An alldiffs.object.

transform.power

> A numeric specifying the power of a transformation, if one has been applied to the response variable. Unless it is equal to 1, the default, back-transforms of the predictions will be obtained and presented in tables or graphs as appropriate. The back-transformation raises the predictions to the power equal to the reciprocal of transform.power, unless it equals 0 in which case the exponential of the predictions is taken.

offset     A numeric that has been added to each value of the response after any scaling and before applying any power transformation.

scale     A numeric by which each value of the response has been multiplied before adding any offset and applying any power transformation.

...     Provision for passssing arguments to functions called internally - not used at present.

#### Value

An alldiffs.object with components predictions, vcov, differences, p.differences, sed, LSD and backtransforms.

#### Author(s)

Chris Brien

#### See Also

asremlPlus-package, as.alldiffs, sort.alldiffs, subset.alldiffs, print.alldiffs, renewClassify.alldiffs, redoErrorIntervals.alldiffs, plotPredictions.data.frame, predictPlus.asreml, predictPresent.asreml

**Examples**

```
data(WaterRunoff.dat)

##Use asreml to get predictions and associated statistics

## Not run:
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = log.Turbidity ~ Benches + (Sources * (Type + Species)),
                      random = ~ Benches:MainPlots,
                      keep.order=TRUE, data= WaterRunoff.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
TS.diffs <- predictPlus(classify = "Sources:Type",
                        asreml.obj = current.asr,
                        wald.tab = current.asrt$wald.tab,
                       present = c("Sources", "Type", "Species"))

## End(Not run)

## Use lmeTest and emmmeans to get predictions and associated statistics

if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(log.Turbidity ~ Benches + (Sources * (Type + Species)) +
                              (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  TS.emm <- emmeans::emmeans(m1.lmer, specs = ~ Sources:Species)
  TS.preds <- summary(TS.emm)
  den.df <- min(TS.preds$df, na.rm = TRUE)
  ## Modify TS.preds to be compatible with a predictions.frame
  TS.preds <- as.predictions.frame(TS.preds, predictions = "emmean",
                                   se = "SE", interval.type = "CI",
                                   interval.names = c("lower.CL", "upper.CL"))

  ## Form an all.diffs object and check its validity
  TS.vcov <- vcov(TS.emm)
  TS.diffs <- allDifferences(predictions = TS.preds, classify = "Sources:Species",
                             vcov = TS.vcov, tdf = den.df)
  validAlldiffs(TS.diffs)
}

## Plot p-values for predictions obtained using asreml or lmerTest
if (exists("TS.diffs"))
{
  ##Recalculate the LSD values for predictions obtained using asreml or lmerTest
  TS.diffs <- addBacktransforms.alldiffs(TS.diffs, transform.power = 0)
}
```

---

allDifferences.data.frame

*Using supplied predictions and standard errors of pairwise differences*
*or the variance matrix of predictions, forms all pairwise differences*
*between the set of predictions, and p-values for the differences.*

---

**Description**

Uses supplied predictions and standard errors of pairwise differences, or the variance matrix of predictions to form, in an alldiffs.object, for those components not already present, (i) a table of all pairwise differences of the predictions, (ii) the p-value of each pairwise difference, and (iii) the minimum, mean and maximum LSD values. Predictions that are aliased (or nonestimable) are removed from the predictions component of the alldiffs.object and standard errors of differences involving them are removed from the sed component.

If necessary, the order of the columns of the variables in the predictions component are changed to be the initial columns of the predictions.frame and to match their order in the classify. Also, the rows of predictions component are ordered so that they are in standard order for the variables in the classify. That is, the values of the last variable change with every row, those of the second-last variable only change after all the values of the last variable have been traversed; in general, the values of a variable are the same for all the combinations of the values to the variables to its right in the classify. The sortFactor or sortOrder arguments can be used to order of the values for the classify variables, which is achieved using sort.alldiffs.

Each p-value is computed as the probability of a t-statistic as large as or larger than the absolute value of the observed difference divided by its standard error. The p-values are stored in the p.differences component. The degrees of freedom of the t-distribution is the degrees of freedom stored in the tdf attribute of the alldiffs.object. This t-distribution is also used in calculating the LSD statistics stored in the alldiffs.object.

**Usage**

```
## S3 method for class 'data.frame'
allDifferences(predictions, classify, vcov = NULL,
               differences = NULL, p.differences = NULL, sed = NULL,
               LSD = NULL, meanLSD.type = "overall", LSDby = NULL,
               backtransforms = NULL,
               response = NULL, response.title = NULL,
               term = NULL, tdf = NULL,
               x.num = NULL, x.fac = NULL,
               level.length = NA,
               pairwise = TRUE, alpha = 0.05,
               transform.power = 1, offset = 0, scale = 1,
               inestimable.rm = TRUE,
               sortFactor = NULL, sortWithinVals = NULL,
               sortOrder = NULL, decreasing = FALSE, ...)
```

**Arguments**

predictions    A predictions.frame, or a data.frame, beginning with the variables classifying the predictions and also containing columns named predicted.value, standard.error and est.status; each row contains a single predicted value. It may also contain columns for the lower and upper limits of error intervals for the predictions. Note that the names standard.error and est.status have been changed to std.error and status in the pvals component produced by asreml-R4; if the new names are in the data.frame supplied to predictions, they will be returned to the previous names.

classify    A character string giving the variables that define the margins of the multiway table that has been predicted. Multiway tables are specified by forming an interaction type term from the classifying variables, that is, separating the variable names with the : operator.

vcov            A matrix containing the variance matrix of the predictions; it is used in com-
                puting the variance of linear transformations of the predictions.

differences     A matrix containing all pairwise differences between the predictions; it should
                have the same number of rows and columns as there are rows in predictions.

p.differences   A matrix containing p-values for all pairwise differences between the predic-
                tions; each p-value is computed as the probability of a t-statistic as large as or
                larger than the observed difference divided by its standard error. The degrees of
                freedom of the t distribution for computing it are computed as the denominator
                degrees of freedom of the F value for the fixed term, if available; otherwise, the
                degrees of freedom stored in the attribute tdf are used; the matrix should be of
                the same size as that for differences.

sed             A matrix containing the standard errors of all pairwise differences between the
                predictions; they are used in computing the p-values.

LSD             A data.frame containing the mean, minimum and maximum LSD for deter-
                mining the significance of pairwise differences, the mean LSD being calculated
                using the square root of the mean of the variances of pairwise differences. If
                factor.combination was specified for meanLSD.type when the LSDs were
                being calculated, then LSD contains an LSD for each factor.combination of
                the [factor](#)s specified by LSDby. Each LSD is calculated from the square root
                of the mean of the variances for all pairwise differences for each factor combi-
                nation, unless there is only one predicted value for each factor.combination,
                when it is based on the standard error of the prediction multiplied by the square
                root of two. If LSD is not NULL then the overall mean LSD will be added as
                an attribute named meanLSD of the [alldiffs.object](#), as will the values of
                meanLSD.type and LSDby. The LSD for a single prediction assumes that any
                predictions to be compared are independent; this is not the case if residual er-
                rors are correlated.

meanLSD.type    A [character](#) string determining whether the mean LSD stored is (i) the overall
                mean, based on the square root of the mean of the variances of all pairwise vari-
                ances, (ii) the mean for each factor.combination of the [factor](#)s specified by
                LSDby, which is based on the square root of the mean of the variances for all pair-
                wise differences for each factor combination, unless there is only one prediction
                for a factor.combination, when notional LSDs are calculated that are based
                on the standard error of the prediction multiplied by the square root of two, or
                (iii) the per.prediction mean, based, for each prediction, on the square root
                of the mean of the variances for all pairwise differences involving that predic-
                tion. If LSD is not NULL then meanLSD.type will be added as an attribute of the
                [alldiffs.object](#).

LSDby           A [character](#) (vector) of variables names, being the names of the [factor](#)s or
                [numeric](#)s in the classify for each combination of which a mean LSD, minLSD
                and max LSD is stored in the LSD component of the [alldiffs.object](#) when
                meanLSD.type is factor.combinatons.

backtransforms  A data.frame containing the backtransformed values of the predicted values
                that is consistent with the predictions component, except that the column
                named predicted.value is replaced by one called backtransformed.predictions.
                Any error.interval values will also be the backtransformed values. Each row
                contains a single predicted value.

response        A character specifying the response variable for the predictions. It is stored as
                an attribute to the [alldiffs.object](#).

response.title  A character specifying the title for the response variable for the predictions. It
                is stored as an attribute to the [alldiffs.object](#).

| term | A character string giving the variables that define the term that was fitted using asreml and that corresponds to classify. It is often the same as classify. It is stored as an attribute to the alldiffs.object. |
|---|---|
| tdf | an integer specifying the degrees of freedom of the standard error. It is used as the degrees of freedom for the t-distribution on which p-values and confidence intervals are based. It is stored as an attribute to the alldiffs.object. |
| x.num | A character string giving the name of the numeric covariate that corresponds to x.fac, is potentially included in terms in the fitted model and which corresponds to the x-axis variable. It should have the same number of unique values as the number of levels in x.fac. |
| x.fac | A character string giving the name of the factor that corresponds to x.num, is potentially included in terms in the fitted model and which corresponds to the x-axis variable. It should have the same number of levels as the number of unique values in x.num. The levels of x.fac must be in the order in which they are to be plotted - if they are dates, then they should be in the form yyyymmdd, which can be achieved using as.Date. However, the levels can be non-numeric in nature, provided that x.num is also set. |
| level.length | The maximum number of characters from the the levels of factors to use in the row and column labels of the tables of pairwise differences and their p-values and standard errors. |
| pairwise | A logical indicating whether all pairwise differences of the predictions and their standard errors and p-values are to be computed and stored. If FALSE, the components differences and p.differences will be NULL in the returned alldiffs.object. |
| alpha | The significance level for an LSD to compare a pair of predictions. |
| transform.power | A numeric specifying the power of a transformation, if one has been applied to the response variable. Unless it is equal to 1, the default, back-transforms of the predictions will be obtained and presented in tables or graphs as appropriate. The back-transformation raises the predictions to the power equal to the reciprocal of transform.power, unless it equals 0 in which case the exponential of the predictions is taken. |
| offset | A numeric that has been added to each value of the response after any scaling and before applying any power transformation. |
| scale | A numeric by which each value of the response has been multiplied before adding any offset and applying any power transformation. |
| inestimable.rm | A logical indicating whether rows for predictions that are not estimable are to be removed from the components of the alldiffs.object. |
| sortFactor | A character containing the name of the factor that indexes the set of predicted values that determines the sorting of each component of the the alldiffs.object by sort.alldiffs. If NULL then sorting is not carried out. If there is more than one variable in the classify term then sortFactor is sorted for the predicted values within each combination of the values of the sortWithin variables: the classify variables, excluding the sortFactor. There should be only one predicted value for each unique value of sortFactor within each set defined by a combination of the values of the sortWithin variables. |
| sortWithinVals | A list with a component named for each factor and numeric that is a classify variable for the predictions, excluding sortFactor. Each component should contain a single value that is a value of the variable. The combination of this |

set of values will be used to define a subset of the predicted values whose order will define the order of sortFactor to be used for all combinations of the sortWithinVals variables. If sortWithinVals is NULL then the first value of each sortWithin variable in predictions component is used to define sortWithinVals. If there is only one variable in the classify then sortWithinVals is ignored.

sortOrder    A character vector whose length is the same as the number of levels for sortFactor in the predictions component of the alldiffs.object. It specifies the desired order of the levels in the reordered components of the alldiffs.object. The argument sortWithinVals is ignored.

The following creates a sortOrder vector levs for factor f based on the values in x:

levs <-levels(f)[order(x)].

decreasing   A logical passed to order that detemines whether the order for sorting the components of the alldiffs.object is for increasing or decreasing magnitude of the predicted values.

...          provision for passsing arguments to functions called internally - not used at present.

## Value

An alldiffs.object with components predictions, vcov, differences, p.differences sed, and LSD.

The name of the response, the response.title, the term, the classify, tdf, sortFactor and the sortOrder will be set as attributes to the object. Note that the classify in an alldiffs.object is based on the variables indexing the predictions, which may differ from the classify used to obtain the original predictions (for example, when the alldiffs.objects stores a linear transformation of predictions.

Also, see predictPlus.asreml for more information.

## Author(s)

Chris Brien

## See Also

asremlPlus-package, as.alldiffs, as.predictions.frame, sort.alldiffs, subset.alldiffs, print.alldiffs, renewClassify.alldiffs, redoErrorIntervals.alldiffs, recalcLSD.alldiffs, plotPredictions.data.frame, predictPlus.asreml, predictPresent.asreml

## Examples

```
data(Oats.dat)

## Use asreml to get predictions and associated statistics

## Not run:
m1.asr <- asreml(Yield ~ Nitrogen*Variety,
                 random=~Blocks/Wplots,
                 data=Oats.dat)
current.asrt <- as.asrtests(m1.asr)
Var.pred <- asreml::predict.asreml(m1.asr, classify="Nitrogen:Variety",
                                   sed=TRUE)
```

```
    if (getASRemlVersionLoaded(nchar = 1) == "3")
      Var.pred <- Var.pred$predictions
    Var.preds <- Var.pred$pvals
    Var.sed <- Var.pred$sed
    Var.vcov <- NULL
    wald.tab <-  current.asrt$wald.tab
    den.df <- wald.tab[match("Variety", rownames(wald.tab)), "denDF"]

  ## End(Not run)

  ## Use lmerTest and emmmeans to get predictions and associated statistics
  if (requireNamespace("lmerTest", quietly = TRUE) &
      requireNamespace("emmeans", quietly = TRUE))
  {
    m1.lmer <- lmerTest::lmer(Yield ~ Nitrogen*Variety + (1|Blocks/Wplots),
                              data=Oats.dat)
    Var.emm <- emmeans::emmeans(m1.lmer, specs = ~ Nitrogen:Variety)
    Var.preds <- summary(Var.emm)
    den.df <- min(Var.preds$df)
    ## Modify Var.preds to be compatible with a predictions.frame
    Var.preds <- as.predictions.frame(Var.preds, predictions = "emmean",
                                      se = "SE", interval.type = "CI",
                                      interval.names = c("lower.CL", "upper.CL"))
    Var.vcov <- vcov(Var.emm)
    Var.sed <- NULL
  }

  ## Use the predictions obtained with either asreml or lmerTest
  if (exists("Var.preds"))
  {
    ## Order the Varieties in decreasing order for the predictions values in the
    ## first N level
    Var.diffs <- allDifferences(predictions = Var.preds,
                                classify = "Nitrogen:Variety",
                                sed = Var.sed, vcov = Var.vcov, tdf = den.df,
                                sortFactor = "Variety", decreasing = TRUE)
    print.alldiffs(Var.diffs, which="differences")

    ## Change the order of the factors in the alldiffs object and reorder components
    Var.reord.diffs <- allDifferences(predictions = Var.preds,
                                classify = "Variety:Nitrogen",
                                sed = Var.sed, vcov = Var.vcov, tdf = den.df)
    print.alldiffs(Var.reord.diffs, which="predictions")
  }
```

---

alldiffs.object          *Description of an alldiffs object*

---

## Description

An object of S3-class `alldiffs` that that stores the predictions for a model, along with supplied statistics for all pairwise differences. While alldiffs.object can be constructed by defining a `list` with the appropriate components, it can be formed by passing the components to as.alldiffs, or from a `predictions` data.frame using allDifferences.data.frame.

as.alldiffs is function that assembles an object of this class from supplied components.

is.alldiffs is the membership function for this class; it tests that an object is of class alldiffs.

validAlldiffs(object) can be used to test the validity of an object with this class.

allDifferences.data.frame is the function that constructs an object of this class by calculating components from statistics supplied via its arguments and then using as.alldiffs to make the object.

**Value**

A list of class alldiffs containing the following components: predictions, vcov, differences, p.differences, sed, LSD and backtransforms. Except for predictions, the components are optional and can be set to NULL.

An alldiffs.object also has attributes response, response.title, term, classify, tdf, sortFactor and sortOrder, which may be set to NULL.

The details of the components are as follows:

1. predictions: A predictions.frame, being a data.frame beginning with the variables classifying the predictions, in the same order as in the classify, and also containing columns named predicted.value, standard.error and est.status; each row contains a single predicted value. The number of rows should equal the number of unique combinations of the classify variables and will be in standard order for the classify variables. That is, the values of the last variable change with every row, those of the second-last variable only change after all the values of the last variable have been traversed; in general, the values of a variable are the same for all the combinations of the values to the variables to its right in the classify.

   The data.frame may also include columns for the lower and upper values of error intervals, either standard error, confidence or half-LSD intervals. The names of these columns will consist of three parts separated by full stops: 1) the first part will be lower or upper; 2) the second part will be one of Confidence, StandardError or halfLeastSignificant; 3) the third component will be limits.

   Note that the names standard.error and est.status have been changed to std.error and status in the pvals component produced by asreml-R4; if the new names are in the data.frame supplied to predictions, they will be returned to the previous names.

2. differencesA matrix containing all pairwise differences between the predictions; it should have the same number of rows and columns as there are rows in predictions.

3. p.differences: A matrix containing p-values for all pairwise differences between the predictions; each p-value is computed as the probability of a t-statistic as large as or larger than the observed difference divided by its standard error. The degrees of freedom of the t distribution for computing it are computed as the denominator degrees of freedom of the F value for the fixed term, if available; otherwise, the degrees of freedom stored in the attribute tdf are used; the matrix should be of the same size as that for differences.

4. sed: A matrix containing the standard errors of all pairwise differences between the predictions; they are used in computing the p-values in p.differences.

5. vcov: A matrix containing the variance matrix of the predictions; it is used in computing the variance of linear transformations of the predictions.

6. LSD: A data.frame containing the mean, minimum and maximum LSD for determining the significance of pairwise differences, the mean LSD being calculated using the square root of the mean of the variances of pairwise differences. If factor.combination was specified for meanLSD.type when the LSDs were being calculated, then LSD contains an LSD for each factor.combination of the factors specified by LSDby. Each LSD is calculated from the

square root of the mean of the variances for all pairwise differences for each factor combination, unless there is only one prediction for a factor.combination, when notional LSDs are calculated that are based on the standard error of the prediction multiplied by the square root of two. If LSD is not NULL then the overall mean LSD will be added as an attribute named meanLSD of the alldiffs.object, as will the values of meanLSD.type and LSDby. The LSD for a single prediction assumes that any predictions to be compared are independent; this is not the case if residual errors are correlated.

7. backtransforms: When the response values have been transformed for analysis, a data.frame containing the backtransformed values of the predicted values is added to the alldiffs.object. This data.frame is consistent with the predictions component, except that the column named predicted.value is replaced by one called backtransformed.predictions. Any error.interval values will also be the backtransformed values. Each row contains a single predicted value.

The details of the attributes of an alldiffs.object are:

1. response: A character specifying the response variable for the predictions.

2. response.title: A character specifying the title for the response variable for the predictions.

3. term: A character string giving the variables that define the term that was fitted using asreml and that corresponds to classify. It is often the same as classify.

4. classify: A character string giving the variables that define the margins of the multiway table used in the prediction. Multiway tables are specified by forming an interaction type term from the classifying variables, that is, separating the variable names with the : operator.

5. tdf: An integer specifying the degrees of freedom of the standard error. It is used as the degrees of freedom for the t-distribution on which p-values and confidence intervals are based.

6. meanLSD: If the LSD component is not NULL then the mean LSD is added as an attribute, calculated using the square root of the mean of the variances of pairwise differences.

7. meanLSD.type: If the LSD component is not NULL then meanLSD.type is added as an attribute.

8. LSDby: If the LSD component is not NULL then LSDby is added as an attribute.

9. sortFactor: A character containing the name of the factor that indexes the set of predicted values that determined the sorting of the components.

10. sortOrder: A character vector that is the same length as the number of levels for sortFactor in the predictions component of the alldiffs.object. It specifies the order of the levels in the reordered components of the alldiffs.object.

The following creates a sortOrder vector levs for factor f based on the values in x:
levs <-levels(f)[order(x)].

See predictPlus.asreml for more information.

## Author(s)

Chris Brien

## See Also

is.alldiffs, as.alldiffs, validAlldiffs, allDifferences.data.frame

## Examples

```
data(Oats.dat)

## Use asreml to get predictions and associated statistics

## Not run:
m1.asr <- asreml(Yield ~ Nitrogen*Variety,
                 random=~Blocks/Wplots,
                 data=Oats.dat)
current.asrt <- as.asrtests(m1.asr)
Var.pred <- asreml::predict.asreml(m1.asr, classify="Nitrogen:Variety",
                                   sed=TRUE)
if (getASRemlVersionLoaded(nchar = 1) == "3")
  Var.pred <- Var.pred$predictions
Var.preds <- Var.pred$pvals
Var.sed <- Var.pred$sed
Var.vcov <- NULL

## End(Not run)

## Use lmerTest and emmmeans to get predictions and associated statistics
if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(Yield ~ Nitrogen*Variety + (1|Blocks/Wplots),
                            data=Oats.dat)
  Var.emm <- emmeans::emmeans(m1.lmer, specs = ~ Nitrogen:Variety)
  Var.preds <- summary(Var.emm)
  den.df <- min(Var.preds$df)
  ## Modify Var.preds to be compatible with a predictions.frame
  Var.preds <- as.predictions.frame(Var.preds, predictions = "emmean",
                                    se = "SE", interval.type = "CI",
                                    interval.names = c("lower.CL", "upper.CL"))
  Var.vcov <- vcov(Var.emm)
  Var.sed <- NULL
}

## Use the predictions obtained with either asreml or lmerTest
if (exists("Var.preds"))
{
  ## Form an all.diffs object
   Var.diffs <- as.alldiffs(predictions = Var.preds, classify = "Nitrogen:Variety",
                            sed = Var.sed, vcov = Var.vcov, tdf = den.df)

  ## Check the class and validity of the alldiffs object
  is.alldiffs(Var.diffs)
  validAlldiffs(Var.diffs)
}
```

---

| angular | *Applies the angular transformation to proportions.* |
|---------|------------------------------------------------------|

---

## Description

Applies the angular transformation to numeric values. It is given by $\sin^{-1}(\sqrt{proportions})$

## Usage

```
angular(proportions, n)
```

## Arguments

| | |
|---|---|
| proportions | The proportions. |
| n | The divisor(s) for each proportion |

## Value

A numeric.

## Author(s)

Chris Brien

## See Also

angular.mod, powerTransform.

## Examples

```
n <-25
y <- rbinom(10, n, 0.5)
y <- c(y,0,n)
p <- y/n
p.ang <- angular(p, n)
```

---

angular.mod *Applies the modified angular transformation to a vector of counts.*

---

## Description

Applies the angular transformation to a vector of counts. A modified transformation is used that is appropriate when N < 50 and the proportion is not between 0.3 and 0.7. The transformation is given by $\sin^{-1} \frac{count+0.375}{n+0.75}$ arcsin( sqrt( (count + 0.375) / (n + 0.75) ) ).

## Usage

```
angular.mod(count, n)
```

## Arguments

| | |
|---|---|
| count | The numeric vector of counts. |
| n | The number(s) of observations from which the count(s) were obtained. |

## Value

A numeric vector.

**Author(s)**

Chris Brien

**See Also**

angular, powerTransform.

**Examples**

```
n <-25
y <- rbinom(10, n, 0.5)
y <- c(y,0,n)
p.ang.mod <- angular.mod(y, n)
```

---

| as.alldiffs | *Forms an* alldiffs.object *from the supplied predictions, along with those statistics, associated with the predictions and their pairwise differences, that have been supplied.* |
|---|---|

---

**Description**

Creates an alldiffs.object that consists of a list containing the following components: predictions, vcov, differences, p.differences, sed, LSD and backtransforms. Predictions must be supplied to the function while the others will be set only if they are supplied; those not supplied are set to NULL. It also has attributes response, response.title, term, classify, tdf, sortFactor and sortOrder. which will be set to the values supplied or NULL if none are supplied.

**Usage**

```
as.alldiffs(predictions, vcov = NULL, differences = NULL,
            p.differences = NULL, sed = NULL, LSD = NULL,
            backtransforms = NULL,
            response = NULL, response.title = NULL,
            term = NULL, classify = NULL, tdf = NULL,
            sortFactor = NULL, sortOrder = NULL)
```

**Arguments**

predictions     A predictions.frame, being a data.frame beginning with the variables classifying the predictions and also containing columns named predicted.value, standard.error and est.status; each row contains a single predicted value. It may also contain columns for the lower and upper limits of error intervals for the predictions. Note that the names standard.error and est.status have been changed to std.error and status in the pvals component produced by asreml-R4; if the new names are in the data.frame supplied to predictions, they will be returned to the previous names.

differences     A matrix containing all pairwise differences between the predictions; it should have the same number of rows and columns as there are rows in predictions.

p.differences    A `matrix` containing p-values for all pairwise differences between the predictions; each p-value is computed as the probability of a t-statistic as large as or larger than the observed difference divided by its standard error. The degrees of freedom of the t distribution for computing it are computed as the denominator degrees of freedom of the F value for the fixed term, if available; otherwise, the degrees of freedom stored in the attribute `tdf` are used; the matrix should be of the same size as that for `differences`.

sed    A `matrix` containing the standard errors of all pairwise differences between the predictions; they are used in computing the p-values.

vcov    A `matrix` containing the variance matrix of the predictions; it is used in computing the variance of linear transformations of the predictions.

LSD    A `data.frame` containing the mean, minimum and maximum LSD for determining the significance of pairwise differences, the mean LSD being calculated using the square root of the mean of the variances of pairwise differences. If `factor.combination` was specified for `meanLSD.type` when the LSDs were being calculated, then LSD contains an LSD for each `factor.combination` of the [factor](#)s specified by LSDby. Each LSD is calculated from the square root of the mean of the variances for all pairwise differences for each factor combination, unless there is only one prediction for a `factor.combination`, when notional LSDs are calculated that are based on the standard error of the prediction multiplied by the square root of two. If LSD is not NULL then the overall mean LSD will be added as an attribute named meanLSD of the [alldiffs.object](#), as will the values of meanLSD.type and LSDby. The LSD for a single prediction assumes that any predictions to be compared are independent; this is not the case if residual errors are correlated.

backtransforms    A `data.frame` containing the backtransformed values of the predicted values that is consistent with the predictions component, except that the column named predicted.value is replaced by one called backtransformed.predictions. Any error.interval values will also be the backtransformed values. Each row contains a single predicted value.

response    A `character` specifying the response variable for the predictions. It is stored as an attribute to the [alldiffs.object](#).

response.title    A `character` specifying the title for the response variable for the predictions. It is stored as an attribute to the [alldiffs.object](#).

term    A character string giving the variables that define the term that was fitted using `asreml` and that corresponds to `classify`. It is often the same as `classify`. It is stored as an attribute to the [alldiffs.object](#).

classify    A character string giving the variables that define the margins of the multiway table used in the prediction. Multiway tables are specified by forming an interaction type term from the classifying variables, that is, separating the variable names with the : operator. It is stored as an attribute to the [alldiffs.object](#).

tdf    an `integer` specifying the degrees of freedom of the standard error. It is used as the degrees of freedom for the t-distribution on which p-values and confidence intervals are based. It is stored as an attribute to the [alldiffs.object](#).

sortFactor    A `character` containing the name of the `factor` that indexes the set of predicted values that determined the sorting of the components.

sortOrder    A `character` vector that is the same length as the number of levels for `sortFactor` in the predictions component of the [alldiffs.object](#). It specifies the order of the levels in the reordered components of the [alldiffs.object](#).

The following creates a `sortOrder` vector `levs` for factor `f` based on the values in `x`: `levs <-levels(f)[order(x)]`.

## Value

An S3-class alldiffs.object. Also, see predictPlus.asreml for more information.

## Author(s)

Chris Brien

## See Also

asremlPlus-package, alldiffs.object, is.alldiffs, as.alldiffs, print.alldiffs, sort.alldiffs, subset.alldiffs, allDifferences.data.frame, renewClassify.alldiffs, redoErrorIntervals.alldiffs, recalcLSD.alldiffs, predictPlus.asreml, plotPredictions.data.frame, predictPresent.asreml

## Examples

```
data(Oats.dat)

## Use asreml to get predictions and associated statistics

## Not run:
m1.asr <- asreml(Yield ~ Nitrogen*Variety,
                 random=~Blocks/Wplots,
                 data=Oats.dat)
current.asrt <- as.asrtests(m1.asr)
Var.pred <- asreml::predict.asreml(m1.asr, classify="Nitrogen:Variety",
                                   sed=TRUE)
if (getASRemlVersionLoaded(nchar = 1) == "3")
  Var.pred <- Var.pred$predictions
Var.preds <- Var.pred$pvals
Var.sed <- Var.pred$sed
Var.vcov <- NULL

## End(Not run)

## Use lmerTest and emmeans to get predictions and associated statistics
if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(Yield ~ Nitrogen*Variety + (1|Blocks/Wplots),
                            data=Oats.dat)
  Var.emm <- emmeans::emmeans(m1.lmer, specs = ~ Nitrogen:Variety)
  Var.preds <- summary(Var.emm)
  den.df <- min(Var.preds$df)
  ## Modify Var.preds to be compatible with a predictions.frame
  Var.preds <- as.predictions.frame(Var.preds, predictions = "emmean",
                                    se = "SE", interval.type = "CI",
                                    interval.names = c("lower.CL", "upper.CL"))
  Var.vcov <- vcov(Var.emm)
  Var.sed <- NULL
}
```

```
   ## Use the predictions obtained with either asreml or lmerTest
   if (exists("Var.preds"))
   {
     ## Form an all.diffs object
      Var.diffs <- as.alldiffs(predictions = Var.preds, classify = "Nitrogen:Variety",
                                sed = Var.sed, vcov = Var.vcov, tdf = den.df)

     ## Check the class and validity of the alldiffs object
     is.alldiffs(Var.diffs)
     validAlldiffs(Var.diffs)
   }
```

---

as.asrtests                  *Forms an asrtests object that stores (i) a fitted asreml object, (ii) a*
                             *pseudo-anova table for the fixed terms and (iii) a history of changes*
                             *and hypthesis testing used in obtaining the model.*

---

### Description

An [asrtests.object](#) that is a `list` consisting of the components `asreml.obj`, `wald.tab` and `test.summary`.

A call to `as.asrtests` with `test.summary = NULL` re-initializes the `test.summary` `data.frame`.

If there is no `wald.tab`, `wald.asreml` is called. In all cases, [recalcWaldTab](#) is called and any changes made as specified by the the [recalcWaldTab](#) arguments supplied via `...`.

### Usage

```
as.asrtests(asreml.obj, wald.tab = NULL, test.summary = NULL,
            denDF = "numeric", ...)
asrtests(asreml.obj, wald.tab = NULL, test.summary = NULL,
         denDF = "numeric", ...)
```

### Arguments

| | |
|---|---|
| asreml.obj | an asreml object for a fitted model. |
| wald.tab | A `data.frame` containing a pseudo-anova table for the fixed terms produced by `wald.asreml`; it should have 4 or 6 columns. Sometimes `wald.asreml` returns a `data.frame` and at other times a `list`. For example, it may return a `list` when denDF is used. In this case, the Wald component of the `list` is to be extracted and stored. It is noted that, as of asreml version 4, `wald.asreml` has a kenadj argument. |
| test.summary | A `data.frame` with columns term, DF, denDF, p and action containing the results of previous hypothesis tests. |
| denDF | Specifies the enthod to use in computing approximate denominator degrees of freedom when `wald.asreml` is called. Can be none to suppress the computations, numeric for numerical methods, algebraic for algebraic methods or default, the default, to autommatically choose numeric or algebraic computations depending on problem size. The denominator degrees of freedom are calculated according to Kenward and Roger (1997) for fixed terms in the dense part of the model. |
| ... | further arguments passed to `wald.asreml` and [recalcWaldTab](#). |

## Value

An object of S3-class asrtests.

## Author(s)

Chris Brien

## See Also

asremlPlus-package, is.alldiffs, as.alldiffs, recalcWaldTab,
testranfix.asrtests, chooseModel.asrtests, rmboundary.asrtests,
reparamSigDevn.asrtests

## Examples

```
## Not run:
data(Wheat.dat)

# Fit initial model
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)

# Load current fit into an asrtests object
current.asrt <- as.asrtests(current.asr, NULL, NULL)

# Check for and remove any boundary terms
current.asrt <- rmboundary(current.asrt)

## End(Not run)
```

---

as.predictions.frame     *Forms a* predictions.frame *from a* data.frame*, ensuring that the
                          correct columns are present.*

---

## Description

Creates a predictions.frame from a data.frame by adding the class predictions.frame to it,
and renaming the columns containing the predictions, se, est.status and error.intervals.

## Usage

```
as.predictions.frame(data, predictions = NULL, se = NULL, est.status = NULL,
                      interval.type = NULL, interval.names = NULL)
```

## Arguments

| | |
|---|---|
| data | A data.frame containing columns giving the variables that uniquely index the predicted values and columns with the predicted values, their standard errors and, optionally, their estimation status (est.status). |
| predictions | A character giving the name of the column in data that contains the predicted values. This column will be renamed to predicted.value. |

se  A [character](#) giving the name of the column in data that contains the standard errors of the predicted values. This column will be renamed to standard.error.

est.status  A [character](#) giving the name of the column in data that contains the estimation status of the predicted values. It will have a value Estimable for predicted values that have been estimated and a value Aliased for predicted values that are NA. If a column named est.status is not present in data and est.status is NULL, a column est.status will be generated.

interval.type  A [character](#) specifying the type of error.intervals stored in data that require renaming. If NULL, error.intervals will not be renamed, even if they are present. Otherwise, interval.type should be set to one of "CI", "SE" or "halfLSD".

interval.names  A [character](#) specifying the column names of the lower and upper limits stored in data that are to be renamed. The character must be of length two, with the first element being the name of the 'lower' limit and the second element being the name of the 'upper' limit.

## Value

An S3-class [predictions.frame](#).

## Author(s)

Chris Brien

## See Also

[asremlPlus-package](#), [predictions.frame](#), [is.predictions.frame](#), [as.predictions.frame](#)

## Examples

```
   data(Oats.dat)

   ## Use asreml to get predictions and associated statistics

   ## Not run:
   m1.asr <- asreml(Yield ~ Nitrogen*Variety,
                    random=~Blocks/Wplots,
                    data=Oats.dat)
   current.asrt <- as.asrtests(m1.asr)
   Var.pred <- asreml::predict.asreml(m1.asr, classify="Nitrogen:Variety",
                                      sed=TRUE)
   if (getASRemlVersionLoaded(nchar = 1) == "3")
     Var.pred <- Var.pred$predictions
 #Form predictions.frame changing asreml-R4 names to the standard names, if these are present
 Var.preds <- as.predictions.frame(Var.pred$pvals, se = "std.error",
                                     est.status = "status")

## End(Not run)

   ## Use lmerTest and emmmeans to get predictions and associated statistics
   if (requireNamespace("lmerTest", quietly = TRUE) &
       requireNamespace("emmeans", quietly = TRUE))
   {
     m1.lmer <- lmerTest::lmer(Yield ~ Nitrogen*Variety + (1|Blocks/Wplots),
                               data=Oats.dat)
```

```
      Var.emm <- emmeans::emmeans(m1.lmer, specs = ~ Nitrogen:Variety)
      Var.preds <- summary(Var.emm)
      Var.preds <- as.predictions.frame(Var.preds, predictions = "emmean",
                                        se = "SE", interval.type = "CI",
                                        interval.names = c("lower.CL", "upper.CL"))
  }

  ## Check the class and validity of the alldiffs object
  if (exists("Var.preds"))
  {
    is.predictions.frame(Var.preds)
    validPredictionsFrame(Var.preds)
  }
```

---

asremlPlus-deprecated    *Deprecated Functions in the Package asremlPlus*

---

### Description

These functions have been renamed and deprecated in asremlPlus:

1. addrm.terms.asreml and addrm.terms.asrtests -> changeTerms.asrtests,

2. alldiffs -> as.alldiffs,

3. choose.model.asreml and choose.model.asrtests -> chooseModel.asrtests,

4. info.crit and info.crit.asreml -> infoCriteria.asreml,

5. newrcov.asrtests -> changeTerms.asrtests,

6. plotvariofaces.asreml -> plotVariofaces.data.frame,

7. power.transform -> powerTransform,

8. predictiondiffs.asreml -> allDifferences.data.frame,

9. predictionplot.asreml -> plotPredictions.data.frame,

10. predictparallel.asreml -> predictPlus.asreml,

11. pred.present.asreml -> predictPresent.asreml,

12. recalc.wald.tab.asreml and recalc.wald.tab.asrtests -> recalcWaldTab.asrtests,

13. reorderClassify and reorderClassify.alldiffs -> renewClassify.alldiffs,

14. reml.lrt and reml.lrt.asreml -> REMLRT.asreml,

15. rmboundary.asreml -> rmboundary.asrtests,

16. setvarianceterms.asreml -> setvarianceterms.call,

17. sig.devn.reparam.asreml and sig.devn.reparam.asrtests -> reparamSigDevn.asrtests,

18. testranfix.asreml -> testranfix.asrtests,

19. testrcov.asreml and testrcov.asrtests -> testresidual.asrtests,

20. testswapran.asreml -> testswapran.asrtests

## Usage

```
addrm.terms.asreml(...)
addrm.terms.asrtests(...)
alldiffs(...)
choose.model.asreml(...)
choose.model.asrtests(...)
info.crit(...)
info.crit.asreml(...)
newrcov.asrtests(...)
plotvariofaces.asreml(...)
power.transform(...)
predictiondiffs.asreml(...)
predictionplot.asreml(...)
predictparallel.asreml(...)
pred.present.asreml(...)
recalc.wald.tab.asreml(...)
recalc.wald.tab.asrtests(...)
reml.lrt(...)
reml.lrt.asreml(...)
## S3 method for class 'alldiffs'
reorderClassify(...)
## S3 method for class 'asreml'
rmboundary(...)
setvarianceterms.asreml(...)
sig.devn.reparam.asreml(...)
sig.devn.reparam.asrtests(...)
testranfix.asreml(...)
testrcov.asreml(...)
testrcov.asrtests(...)
## S3 method for class 'asreml'
testswapran(...)
```

## Arguments

...            absorbs arguments passed from the old functions of the style foo.bar().

## Author(s)

Chris Brien

---

asremlPlusTips          *The randomly-presented, startup tips.*

---

## Description

The intermittent, randomly-presented, startup tips.

**Startup tips**

Need help? The manual is a vignette and is in the vignettes subdirectory of the package's install directory.

Find out what has changed in asremlPlus: enter news(package = 'asremlPlus').

Need help getting started? Enter vignette(package = 'asremlPlus').

To avoid start-up message that ASReml-R is needed, load asreml before asremlPlus.

The methods for alldiffs and data.frame do not require asreml

Use suppressPackageStartupMessages() to eliminate all package startup messages.

To see all the intermittent, randomly-presented, startup tips enter ?asremlPlusTips.

To install the latest version: go to http://chris.brien.name/rpackages.

For versions between CRAN releases (and more) go to http://chris.brien.name/rpackages.

**Author(s)**

Chris Brien

---

asrtests.object          *Description of an asrtests object*

---

**Description**

An object of S3-class asrtests that contains information derived from the fits of a mixed model using asreml.

as.asrtests is function that makes an object of this class.

is.list is the membership function for this class; it tests that an object is of class list.

validAsrtests can be used to test the validity of an asrtests.object.

**Value**

A list that contains three components:

1. asreml.obj: an object of class asreml that contains the fit of a model;

2. wald.tab: A data.frame containing a pseudo-anova table for the fixed terms produced by wald.asreml. It has rownames that corresond to the fixed terms that were fitted and four columns. If denominator degrees of freedom were calculated then the columns are Df, denDF, F.inc, Pr; otherwise the columns are Df, Sum of Sq, Wald statistic, and Pr(Chisq).

3. test.summary: A data.frame with columns term, DF, denDF, p and action. A row is added to it for each term that is dropped, added or tested or a note that several terms have been added or removed. A row contains the name of the term, the DF, the p-value and the action taken. Possible codes are: Dropped, Retained, Swapped, Unswapped, Significant, Nonsignificant, Absent, Added, Removed and Boundary. If the changed model did not converge, Unconverged will be added to the code. Note that the logical asreml.obj$converge also reflects whether there is convergence.

**Author(s)**

Chris Brien

**See Also**

as.asrtests, as.asrtests, validAsrtests

---

bootREMLRT.asreml      *Uses the parametric bootstrap to calculate the p-value for a REML ratio test to compare two models.*

---

**Description**

Extracts the REML log likelihood for two asreml objects and forms the observed REML ratio statistic. It assumes that the second asreml object is the result of fitting a model that is a reduced version of the model for the first object and is considered to the null model. Using the mean and V, nboot bootstrap samples of simulated response values are generated in parallel; that is, ncores cores are used and each is used to generate and analyse a sample. The full and reduced models are fitted to the data and if either analysis fails to converge another sample is generated and analysed using the current core, with a maximum of max.retries attempts to obtain a sample that converges for both analysis. Thus the maximum number of data sets that will be generated is nboot * max.retries. If a bootstrap sample converges for both analyses, the REML ratio test statistic is formed for it. The p-value is then calculated as $(k+1)/(b+1)$ where $k$ is the number of simulated ratio test statistics greater than the observed test statistic and $s$ is the number of bootstrap samples that were returned.

The function checks that the models do not differ in either their fixed or sparse models. It also check the difference in the number of variance parameters between the two fits to the models, taking into account the bound.exclusions.

**Usage**

```
## S3 method for class 'asreml'
bootREMLRT(h0.asreml.obj, h1.asreml.obj,
           nboot = 100, max.retries = 5, seed = NULL,
           means=NULL, V = NULL, extra.matrix = NULL, ignore.terms = NULL,
           fixed.spline.terms = NULL,
           bound.exclusions = c("F","B","S","C"),
           tolerance = 1E-10, update = TRUE, trace = FALSE,
           ncores = detectCores(), ...)
```

**Arguments**

| | |
|---|---|
| h0.asreml.obj | asreml object containing the fit under the model for the null hypothesis. |
| h1.asreml.obj | asreml object containing the fit under the model for the alternative hypothesis. |
| nboot | The number of bootstrap samples to be generated. |
| max.retries | The maximum number of attempts to generate a sample whose analyses converge for both models. |
| seed | A single value, interpreted as an integer, that specifies the starting value of the random number generator. The "L'Ecuyer-CMRG" random generator is used and nextRNGStream is used to seed each core from the original seed. |
| means | The vector of means to be used in generating simulated bootstrap samples. If it is NULL, the fitted values based on object are used. It must be the same length as the response variable for object. |

V                          The fitted variance matrix, i.e. having the pattern and values that conform to
                           the model fit stored in the supplied object. If it is NULL, estimateV.asreml
                           is used to estimate the variance matrix for the observations from the variance
                           parameter estimates from the reduced.asreml.obj.

extra.matrix               A matrix of order equal to the number of observations that is to be added to
                           the variance matrix, the latter based on the information in asreml.obj. It is
                           assumed that the sigma-parameterized values of the variance parameter esti-
                           mates, such as is given in the varcomp component of summary.asreml, have
                           been used in calculating extra.matrix; the values in the vparameters compo-
                           nent of G.param and R.param may be either gamma- or sigma-parameterized.
                           The argument extra.matrix can be used in conjunction with ignore.terms as
                           a workaround to include components of the variance matrix for variance func-
                           tions that have not been implemented in estimateV.

ignore.terms               A character giving terms from either the random or residual models that are
                           to be ignored in that their contributions to the variance is not to be included in the
                           estimated matrix. The term names are those given in the vparameters compo-
                           nent of the asreml object or the varcomp component produced by summary.asreml,
                           but only up to the first exclamation mark (!). This can be used in conjunction
                           with estimateV.asreml as a workaround to include components of the variance
                           matrix for variance functions that have not been implemented in estimateV.

fixed.spline.terms
                           A character vector giving one or mor spline terms in the random model that are
                           regarded as fixed and so are to be ignored because they are not regarded as con-
                           tributing to the variance. The term names are those given in the vparameters
                           component of the asreml object or the varcomp component produced by summary.asreml,
                           but only up to the first exclamation mark (!).

bound.exclusions
                           A character specifying one or more bound codes that will result in a variance
                           parameter in the random model being excluded from contributing to the vari-
                           ance. If set to NULL then none will be excluded.

tolerance                  The value such that eigenvalues less than it are considered to be zero.

update                     If TRUE then the arguments R.param and G.param are set to those in the asreml
                           object supplied in object so that the values from the original model are used
                           as starting values. If FALSE then calls are made to asreml in which the only
                           changes from the previous call are (i) the model is fitted to simulated data and
                           (ii) modifications specified via ... are made, except that changes cannot be
                           made to any of the models.

trace                      If TRUE then partial iteration details are displayed when ASReml-R functions are
                           invoked; if FALSE then no output is displayed.

ncores                     A numeric specifying the number of cores to use in doing the simulations.

...                        Other arguments that are passed down to the function asreml. Changes to the
                           models are not allowed. Other changes are dangerous and generally should be
                           avoided.

## Value

A list with the following components:

1. **REMLRT:** the observed REML ratio statistic.

2. **p:** the bootstrap p-value for the observed test statistic.

3. **DF:** the calculated difference in DF for the variance parameters in the two models.

4. **totalunconverged:** the total number of unconverged analyses over the simulations.

5. **REMLRT.sim:** a `numeric` containing the values of the ratio statistics for the simulated data. It has an attribute called na.action that can be retrieved using `attr(REMLRT.sim,which = "na.action")`; it contains a list of the simulation numbers that were abandoned because `max.retries` failed to converge for both models.

6. **nunconverged:** the number of unconverged analyses for each bootstap sample, the maximum being `max.retries`.

**Note**

A boostrap sample is generated using a multivariate normal distribution with expected value as specified by `means` and variance matrix given by `V`. Each simulated sample is analysed according to the reduced model and, provided this analysis converges, according to the full.model. If one of these analyses fails to converge, it is abandoned and another sample is generated for this simulation. As many as `max.retries` attempts are made to generate a data set for which both analyses converge. If data set that converges for both analyses is not generated for a simulation, NA is returned for that bootstrap sample. Hence, the maximum number of data sets that will be generated is nboot * `max.retries` and less than nboot samples will be generated if a data set that converges for both analyses is not obtained within `max.retries` attempts.

If a bootstrap sample converges for both analyses, the REML ratio test statistic is calculated as $2(log(REML)_F - log(REML)_R)$.

The DF is calculated from the information in `full.asreml.obj` and `reduced.asreml.obj`. The degrees of freedom are computed as the difference between the two models in the number of variance parameters whose estimates do not have a code for bound specified in `bound.exclusions`.

If ASReml-R version 4 is being used then the codes specified in `bound.exclusions` are not restricted to a subset of the default codes, but a warning is issued if a code other than these is specified. For ASReml-R version 3, only a subset of the default codes are allowed: F (Fixed), B (Boundary), C (Constrained) and S (Singular).

**Author(s)**

Chris Brien

**See Also**

[REMLRT.asreml](), [infoCriteria.asreml](), [testranfix.asrtests]()

**Examples**

```
## Not run:
    bootREMLRT(ICV.max, ICV.red, ncores = 2)

## End(Not run)
```

changeTerms.asrtests    *Adds and drops the specified sets of terms from one or both of the fixed or random model and/or replaces the residual (rcov) model with a new model.*

## Description

The specified terms are simply added or dropped, without testing, from either the fixed or random model and/or the residual (rcov) model replaced. No hypothesis testing is performed, but a check is made for boundary or singular terms. A row is added to the test.summary data.frame using the supplied label and stating which models have been changed. Convergence in fitting the model is checked and a note included in the action if there was not. All components of the asrtests.object are updated.

## Usage

```
## S3 method for class 'asrtests'
changeTerms(asrtests.obj,
            dropFixed = NULL, addFixed = NULL,
            dropRandom = NULL,  addRandom = NULL,
            newResidual = NULL, label = "Changed terms",
            allow.unconverged = TRUE, checkboundaryonly = FALSE,
            trace = FALSE, update = TRUE, denDF = "numeric",
            set.terms = NULL, ignore.suffices = TRUE,
            bounds = "P", initial.values = NA, ...)
```

## Arguments

asrtests.obj    An asrtests.object containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary.

dropFixed       A single character string in the form of a formula which, after addition of ". ~ . -" and after expansion, specifies the sum of a set of terms to be dropped from the fixed formula.

addFixed        A single character string in the form of a formula which, after addition of ". ~ . +" and expansion, specifies the sum of a set of terms to be added to the fixed formula.

dropRandom      A single character string in the form of a formula which, after addition of " ~ . -" and expansion, specifies the sum of a set of terms to be dropped from the random formula.

addRandom       A single character string in the form of a formula which, after addition of " ~ . +"and expansion, specifies the sum of a set of terms to be added to the random formula.

newResidual     A single character string in the form of a formula which, after addition of " ~ ", specifies the residual (or rcov) model. To remove the model, enter "-(.)".

label           A character string to use as the label in test.summary and which indicates what is being tested.

allow.unconverged

                A logical indicating whether to accept a new model even when it does not converge. If FALSE and the fit does not converge, the supplied asreml object is returned.

checkboundaryonly

If TRUE then boundary and singular terms are not removed by [rmboundary.asrtests](#); a warning is issued instead.

trace                If TRUE then partial iteration details are displayed when ASReml-R functions are invoked; if FALSE then no output is displayed.

update              If TRUE then update.asreml is called to fit the model to be tested. In doing this the arguments R.param and G.param are set to those in the asreml object stored in asrtests.obj so that the values from the previous model are used as starting values. If FALSE then a call is made to asreml in which the only changes from the previous call are that (i) models are modifed as specified and (ii) modifications specified via ... are made.

denDF               Specifies the enthod to use in computing approximate denominator degrees of freedom when wald.asreml is called. Can be none to suppress the computations, numeric for numerical methods, algebraic for algebraic methods or default, the default, to autommatically choose numeric or algebraic computations depending on problem size. The denominator degrees of freedom are calculated according to Kenward and Roger (1997) for fixed terms in the dense part of the model.

set.terms           A character vector specifying the terms that are to have bounds and/or initial values set prior to fitting.

ignore.suffices

A logical vector specifying whether the suffices of the asreml-assigned names of the variance terms (i.e. the information to the right of an "!", other than "R!") is to be ignored in matching elements of terms. If TRUE for an element of terms, the suffices are stripped from the asreml-assigned names. If FALSE for an element of terms, the element must exactly match an asreml-assigned name for a variance term. This vector must be of length one or the same length as terms. If it is of length one then the same action is applied to the asreml-assigned suffices for all the terms in terms.

bounds              A [character](#) vector specifying the bounds to be applied to the terms specified in set.terms. This vector must be of length one or the same length as set.terms. If it is of length one then the same constraint is applied to all the terms in set.terms. If any of the bounds are equal to NA then they are left unchanged for those terms.

initial.values      A character vector specifying the initial values for the terms specified in terms. This vector must be of length one or the same length as terms. If it is of length one then the same initial value is applied to all the terms in terms. If any of the initial.values are equal to NA then they are left unchanged for those terms.

...                 Further arguments passed to asreml, wald.asreml and [as.asrtests](#).

## Value

An [asrtests.object](#) containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary.

## Author(s)

Chris Brien

## See Also

[as.asrtests](#), [rmboundary.asrtests](#), [testranfix.asrtests](#), [testresidual.asrtests](#), [newfit.asreml](#), [reparamSigDevn.asrtests](#), [chooseModel.asrtests](#)

**Examples**

```
## Not run:
terms <- "(Date/(Sources * (Type + Species)))"
current.asrt <- changeTerms(current.asrt, addFixed = terms)


current.asrt <- changeTerms(current.asrt, dropFixed = "A + B", denDF = "algebraic")


data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary(current.asrt)
# Add and drop both fixed and random terms
current.asrt <- changeTerms(current.asrt,
                            addFixed = "vRow", dropFixed = "WithinColPairs",
                            addRandom = "spl(vRow)", dropRandom = "units",
                            checkboundaryonly = TRUE)
# Replace residual with model without Row autocorrelation
current.asrt <- changeTerms(current.asrt,
                            newResidual = "Row:ar1(Column)",
                            label="Row autocorrelation")


## End(Not run)
```

---

chooseModel.asrtests     *Determines the set of significant terms taking into account the hier-*
                         *archy or marginality relations and records the tests performed in an*
                         [asrtests.object](asrtests.object).

---

**Description**

Performs a series of hypothesis tests taking into account the marginality of terms. In particular, a
term will not be tested if it is marginal to (or nested in) one that is significant. For example, if A:B
is significant, then neither A nor B will be tested. For a random term, the term is removed from the
model fit, any boundary terms are removed using [rmboundary.asrtests](rmboundary.asrtests) and a REML likelihood
ratio test is performed using [REMLRT.asreml](REMLRT.asreml). If it is not significant and drop.ran.ns is TRUE,
the term is permanently removed from the model. Note that if boundary terms are removed, the
reduced model may not be nested in the full model in which case the test is not valid. For fixed
terms, the Wald tests are performed and the p-value for the term obtained. If it is not significant
and drop.fix.ns is TRUE, the term is permanently removed from the model. A row is added to
test.summary for each term that is tested.

**Usage**

```
## S3 method for class 'asrtests'
chooseModel(asrtests.obj, terms.marginality=NULL,
            alpha = 0.05, allow.unconverged = TRUE,
            checkboundaryonly = FALSE, drop.ran.ns=TRUE,
            positive.zero = FALSE, bound.test.parameters = "none",
            drop.fix.ns=FALSE, denDF = "numeric",  dF.na = "none",
```

```
dDF.values = NULL, trace = FALSE, update = TRUE,
set.terms = NULL, ignore.suffices = TRUE,
bounds = "P", initial.values = NA, ...)
```

## Arguments

asrtests.obj     an [asrtests.object](#) containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary.

terms.marginality
                 A square matrix of ones and zeros with row and column names being the names of the terms. The diagonal elements should be one, indicating that a term is marginal to itself. Elements should be one if the row term is marginal to the column term. All other elements should be zero.

alpha            The significance level for the test.

allow.unconverged
                 A logical indicating whether to accept a new model even when it does not converge. If FALSE and a fit when a term is removed does not converge, the term will not be removed.

checkboundaryonly
                 If TRUE then boundary and singular terms are not removed by [rmboundary.asrtests](#); a warning is issued instead.

drop.ran.ns      A logical indicating whether to drop nonsignificant random terms from the model.

positive.zero    Indicates whether the hypothesized values for the variance components being tested are on the boundary of the parameter space. For example, this is true for positively-constrained variance components that, under the reduced model, are zero. This argument does not need to be set if bound.test.parameters is set.

bound.test.parameters
                 Indicates whether for the variance components being tested, at least some of the hypothesized values are on the boundary of the parameter space. The possibilities are "none", "onlybound" and "one-and-one". The default is "none", although if it is set to "none" and positive.zero is TRUE then bound.test.parameters is taken to be "onlybound". When bound.test.parameters is set to "one-and-one", it signifies that there are two parameters being tested, one of which is bound and the other is not. For example, the latter is true for testing a covariance and a positively-constrained variance component that, under the reduced model, are zero.

drop.fix.ns      A logical indicating whether to drop a fixed term from the model when it is nonsignificant

denDF            Specifies the enthod to use in computing approximate denominator degrees of freedom when wald.asreml is called. Can be none to suppress the computations, numeric for numerical methods, algebraic for algebraic methods or default, the default, to autommatically choose numeric or algebraic computations depending on problem size. The denominator degrees of freedom are calculated according to Kenward and Roger (1997) for fixed terms in the dense part of the model.

dDF.na           The method to use to obtain substitute denominator degrees of freedom. when the numeric or algebraic methods produce an NA. If dDF.na = "none", no substitute denominator degrees of freedom are employed; if dDF.na = "residual", the residual degrees of freedom from asreml.obj$nedf are used; if dDF.na = "maximum", the maximum of those denDF that are available, excluding that for

|  | the Intercept, is used; if all denDF are NA, asreml.obj$nedf is used. If dDF.na = "supplied", a vector of values for the denominator degrees of freedom is to be supplied in dDF.values. Any other setting is ignored and a warning message produced. Generally, substituting these degrees of freedom is anticonservative in that it is likely that the degrees of freedom used will be too large. |
|---|---|
| dDF.values | A vector of values to be used when dDF.na = "supplied". Its values will be used when denDF in a test for a fixed effect is NA. This vector must be the same length as the number of fixed terms, including (Intercept) whose value could be NA. |
| trace | If TRUE then partial iteration details are displayed when ASReml-R functions are invoked; if FALSE then no output is displayed. |
| update | If TRUE then update.asreml is called in testing models. In doing this the arguments R.param and G.param are set to those in the asreml object stored in asrtests.obj so that the values from the previous model are used as starting values. If FALSE then a call is made to asreml in which the only changes to the asreml.obj stored in the supplied asrtests.obj are (i) to the terms in the fixed and random models corresponding to terms in terms.marginality and (ii) those modifications specified via ....  |
| set.terms | A character vector specifying the terms that are to have bounds and/or initial values set prior to fitting. |
| ignore.suffices | |
| | A logical vector specifying whether the suffices of the asreml-assigned names of the variance terms (i.e. the information to the right of an "!", other than "R!") is to be ignored in matching elements of terms. If TRUE for an element of terms, the suffices are stripped from the asreml-assigned names. If FALSE for an element of terms, the element must exactly match an asreml-assigned name for a variance term. This vector must be of length one or the same length as terms. If it is of length one then the same action is applied to the asreml-assigned suffices for all the terms in terms. |
| bounds | A [character](#) vector specifying the bounds to be applied to the terms specified in set.terms. This vector must be of length one or the same length as set.terms. If it is of length one then the same constraint is applied to all the terms in set.terms. If any of the bounds are equal to NA then they are left unchanged for those terms. |
| initial.values | A character vector specifying the initial values for the terms specified in terms. This vector must be of length one or the same length as terms. If it is of length one then the same initial value is applied to all the terms in terms. If any of the initial.values are equal to NA then they are left unchanged for those terms. |
| ... | further arguments passed to asreml, wald.asreml and [as.asrtests](#) via [testranfix.asrtests](#). |

## Value

A list containing:

1. asrtests.obj: an [asrtests.object](#) containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary.;
2. sig.tests: a character vector whose elements are the the significant terms amongst those tested.

## Author(s)

Chris Brien

## See Also

## Examples

```
## Not run:
data(WaterRunoff.dat)
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(log.Turbidity ~ Benches + (Sources * (Type + Species)) * Date,
                      random = ~Benches:MainPlots:SubPlots:spl(xDay),
                      data = WaterRunoff.dat, keep.order = TRUE)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
terms.treat <- c("Sources", "Type", "Species",
                 "Sources:Type", "Sources:Species")
terms <- sapply(terms.treat,
                FUN=function(term){paste("Date:",term,sep="")},
                simplify=TRUE)
terms <- c("Date", terms)
terms <- unname(terms)
marginality <-  matrix(c(1,0,0,0,0,0, 1,1,0,0,0,0,  1,0,1,0,0,0,
                         1,0,1,1,0,0, 1,1,1,0,1,0, 1,1,1,1,1,1), nrow=6)
rownames(marginality) <- terms
colnames(marginality) <- terms
choose <- chooseModel(current.asrt, marginality)
current.asrt <- choose$asrtests.obj
sig.terms <- choose$sig.terms

## End(Not run)
```

---

| estimateV.asreml | *Forms the estimated variance, random or residual matrix for the observations from the variance parameter estimates.* |
|---|---|

---

## Description

Forms the estimated variance (**V**), random (**G**) or (**R**) matrix for the observations, a square symmetric matrix of order equal to the number of observations. The estimates of the variance parameters and the information about the random and residual models for which they were estimated are obtained from the asreml object. This function is not available in ASReml-R version 3.

## Usage

```
## S3 method for class 'asreml'
estimateV(asreml.obj, which.matrix = "V",
          extra.matrix = NULL, ignore.terms = NULL, fixed.spline.terms = NULL,
          bound.exclusions = c("F","B","S","C"), ...)
```

## Arguments

asreml.obj     An asreml object from a call to asreml in which the data argument has been set.

which.matrix     A character giving the matrix that is to be formed. It must be one of "V", to produce the variance matrix **V = G + R**, "G" to produce the matrix **G**, corresponding to the random formula, or "R" to produce the matrix **R**, corresponding to the residual formula.

extra.matrix     A matrix of order equal to the number of observations that is to be added to the matrix specified by which.matrix, the latter based on the information in asreml.obj. It is assumed that the sigma-parameterized values of the variance parameter estimates, such as is given in the varcomp component of summary.asreml, have been used in calculating extra.matrix; the values in the vparameters component of G.param and R.param may be either gamma- or sigma-parameterized. The argument extra.matrix can be used in conjunction with ignore.terms as a workaround to include components of the variance matrix for variance functions that have not been implemented in estimateV.

ignore.terms     A character giving terms from either the random or residual models that are to be ignored in that their contributions to the variance is not to be included in the estimated matrix. The term names are those given in the vparameters component of the asreml object or the varcomp component produced by summary.asreml, but only up to the first exclamation mark (!). This can be used in conjunction with estimateV.asreml as a workaround to include components of the variance matrix for variance functions that have not been implemented in estimateV.

fixed.spline.terms
                 A character vector giving one or mor spline terms in the random model that are regarded as fixed and so are to be ignored because they are not regarded as contributing to the variance. The term names are those given in the vparameters component of the asreml object or the varcomp component produced by summary.asreml, but only up to the first exclamation mark (!).

bound.exclusions
                 A character specifying one or more bound codes that will result in a variance parameter in the random model being excluded from contributing to the variance. If set to NULL then none will be excluded.

...              Provision for passsing arguments to functions called internally - not used at present.

## Details

The information about the variance parameters in the fitted mixed model are obtained from the G.param and R.param components of the asreml object. The function can deal with the following variance functions in either the random or residual models: id, diag, us, ar1, ar2, ar3, sar,sar2, ma1, ma2, arma, exp, gau, cor, corb and corg. All of these functions, except us, can be combined with either v or h. It will also cope with the following functions in the random model: at, str, spl, dev, grp, fa and rr. Additionally, it can deal with the function dsum in the residual model. For further information see the ASReml-R User Guide Version 4 (Butler et al., 2018).

## Value

A matrix containing the estimated variance matrix.

## Author(s)

Chris Brien

**References**

Butler, D. G., Cullis, B. R., Gilmour, A. R., Gogel, B. J. and Thompson, R. (2018). *ASReml-R Reference Manual Version 4.* VSN International Ltd, http://asreml.org.

**See Also**

asreml, simulate.asreml, variofaces.asreml.

**Examples**

```
## Not run:
data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
# Form variance matrix based on estimated variance parameters
V <- estimateV(current.asr)


## End(Not run)
```

---

| facCombine.alldiffs | *Combines several factors into one in the components of an* alldiffs.object |
|---|---|

---

**Description**

Combines several factors, in the prediction component of object, into one whose levels are the combinations of the used levels of the individual factors. The matching changes are made to the other components of the alldiffs.object. The levels of the factors are combined using fac.combine from the dae package.

**Usage**

```
## S3 method for class 'alldiffs'
facCombine(object, factors, order="standard",
           combine.levels=TRUE, sep="_", level.length = NA, ...)
```

**Arguments**

| | |
|---|---|
| object | An alldiffs.object. |
| factors | A character containing the names of factors in the prediction component of object whose levels are to be combined. |
| order | Either standard or yates. The order in which the levels combinations of the factors are to be considered as numbered when forming the levels of the combined factor; standard numbers them as if they are arranged in standard order, that is with the levels of the first factor moving slowest and those of the last factor moving fastest; yates numbers them as if they are arranged in Yates order, that is with the levels of the first factor moving fastest and those of the last factor moving slowest. |

combine.levels   A `logical` specifying whether the `levels` labels of the new [factor](#) are to be
                 combined from those of the [factor](#)s being combined. The default is to use the
                 integers from 1 to the product of the numbers of combinations of used `levels`
                 of the individual [factor](#)s, numbering the levels according to `order`.

sep              A `character` string to separate the levels when `combine.levels = TRUE`.

level.length     The maximum number of characters from the the levels of factors to use in the
                 row and column labels of the tables of pairwise differences and their p-values
                 and standard errors.

...              Further arguments passed to the [factor](#) call creating the new [factor](#).

## Value

A modified [alldiffs.object](#).

## Author(s)

Chris Brien

## See Also

[as.alldiffs](#), [allDifferences.data.frame](#), [print.alldiffs](#), [sort.alldiffs](#),
[renewClassify.alldiffs](#); fac.combine in package **dae**.

## Examples

```
data("Ladybird.dat")

## Use asreml to get predictions and associated statistics

## Not run:
m1.asr <- asreml(logitP ~ Host*Cadavers*Ladybird,
                 random = ~ Run,
                 data = Ladybird.dat)
current.asrt <- as.asrtests(m1.asr)
HCL.pred <- asreml::predict.asreml(m1.asr, classify="Host:Cadavers:Ladybird",
                                   sed=TRUE)
HCL.preds <- HCL.pred$pvals
HCL.sed <- HCL.pred$sed
HCL.vcov <- NULL
wald.tab <-  current.asrt$wald.tab
den.df <- wald.tab[match("Host:Cadavers:Ladybird", rownames(wald.tab)), "denDF"]

## End(Not run)

  ## Use lmeTest and emmmeans to get predictions and associated statistics
  if (requireNamespace("lmerTest", quietly = TRUE) &
      requireNamespace("emmeans", quietly = TRUE))
  {
    m1.lmer <- lmerTest::lmer(logitP ~ Host*Cadavers*Ladybird + (1|Run),
                              data=Ladybird.dat)
    HCL.emm <- emmeans::emmeans(m1.lmer, specs = ~ Host:Cadavers:Ladybird)
    HCL.preds <- summary(HCL.emm)
    den.df <- min(HCL.preds$df)
    ## Modify HCL.preds to be compatible with a predictions.frame
    HCL.preds <- as.predictions.frame(HCL.preds, predictions = "emmean",
```

```
                                          se = "SE", interval.type = "CI",
                                          interval.names = c("lower.CL", "upper.CL"))
      HCL.vcov <- vcov(HCL.emm)
      HCL.sed <- NULL
    }

    ## Use the predictions obtained with either asreml or lmerTest
    if (exists("HCL.preds"))
    {
      ## Form an all.diffs object
     HCL.diffs <- as.alldiffs(predictions = HCL.preds, classify = "Host:Cadavers:Ladybird",
                              sed = HCL.sed, vcov = HCL.vcov, tdf = den.df)

      ## Check the class and validity of the alldiffs object
      is.alldiffs(HCL.diffs)
      validAlldiffs(HCL.diffs)

      ## Combine Cadavers and Ladybird
      HCL.diffs <- facCombine(HCL.diffs, factors = c("Cadavers","Ladybird"))

      ## Check the validity of HCL.diffs
      validAlldiffs(HCL.diffs)
    }
```

---

facRecode.alldiffs          *Recodes factor levels using values in a vector. The values in the vector*
                            *do not have to be unique.*

---

### Description

Recodes the levels and values of a [factor](), in the prediction component of an [alldiffs.object]()
using each value in the newlevels vector to replace the corresponding value in the vector of levels
of the factor. The matching changes are made to the other components of the [alldiffs.object]().
The levels of the factors are recoded using fac.recode from the dae package.

### Usage

```
## S3 method for class 'alldiffs'
facRecode(object, factor, newlevels,  ...)
```

### Arguments

| | |
|---|---|
| object | An [alldiffs.object](). |
| factor | A [character]() containing the name of a [factor]() in the prediction component of object whose levels are to be recoded. |
| newlevels | A [vector]() of length levels(factor) containing values to use in the recoding. |
| ... | Further arguments passed to the [factor]() call creating the new [factor](). |

### Value

A modified [alldiffs.object]().

**Author(s)**

Chris Brien

**See Also**

[as.alldiffs](), [allDifferences.data.frame](), [print.alldiffs](), [sort.alldiffs](),
[facCombine.alldiffs](), [facRename.alldiffs](), [renewClassify.alldiffs](); fac.recode in package **dae**.

**Examples**

```
    data("Ladybird.dat")

    ## Use asreml to get predictions and associated statistics

    ## Not run:
    m1.asr <- asreml(logitP ~ Host*Cadavers*Ladybird,
                     random = ~ Run,
                     data = Ladybird.dat)
    current.asrt <- as.asrtests(m1.asr)
    HCL.pred <- asreml::predict.asreml(m1.asr, classify="Host:Cadavers:Ladybird",
                                       sed=TRUE)
    HCL.preds <- HCL.pred$pvals
    HCL.sed <- HCL.pred$sed
    HCL.vcov <- NULL
    wald.tab <-  current.asrt$wald.tab
    den.df <- wald.tab[match("Host:Cadavers:Ladybird", rownames(wald.tab)), "denDF"]

  ## End(Not run)

    ## Use lmeTest and emmmeans to get predictions and associated statistics
    if (requireNamespace("lmerTest", quietly = TRUE) &
        requireNamespace("emmeans", quietly = TRUE))
    {
      m1.lmer <- lmerTest::lmer(logitP ~ Host*Cadavers*Ladybird + (1|Run),
                                data=Ladybird.dat)
      HCL.emm <- emmeans::emmeans(m1.lmer, specs = ~ Host:Cadavers:Ladybird)
      HCL.preds <- summary(HCL.emm)
      den.df <- min(HCL.preds$df)
      ## Modify HCL.preds to be compatible with a predictions.frame
      HCL.preds <- as.predictions.frame(HCL.preds, predictions = "emmean",
                                        se = "SE", interval.type = "CI",
                                        interval.names = c("lower.CL", "upper.CL"))
      HCL.vcov <- vcov(HCL.emm)
      HCL.sed <- NULL
    }

    ## Use the predictions obtained with either asreml or lmerTest
    if (exists("HCL.preds"))
    {
      ## Form an all.diffs object
     HCL.diffs <- as.alldiffs(predictions = HCL.preds, classify = "Host:Cadavers:Ladybird",
                              sed = HCL.sed, vcov = HCL.vcov, tdf = den.df)

      ## Check the class and validity of the alldiffs object
      is.alldiffs(HCL.diffs)
```

```
    validAlldiffs(HCL.diffs)

    ## Recode Ladybird
 HCL.diffs <- facRecode(HCL.diffs, factor = "Ladybird", newlevels = c("none", "present"))

    ## Check the validity of HCL.diffs
    validAlldiffs(HCL.diffs)
  }
```

---

facRename.alldiffs       *Renames* factors *in the* prediction *component of an* alldiffs.object.

---

## Description

Renames factors in the prediction component of an alldiffs.object. These changes are propogated to the other components of the alldiffs.object.

## Usage

```
## S3 method for class 'alldiffs'
facRename(object, factor.names, newnames,  ...)
```

## Arguments

| | |
|---|---|
| object | An alldiffs.object. |
| factor.names | A character containing the names of the factors in the prediction component of object that are to be renamed. |
| newnames | A character containing the new names of the factors in the prediction component of object. |
| ... | Provision for passsing arguments to functions called internally - not used at present. |

## Value

A modified alldiffs.object.

## Author(s)

Chris Brien

## See Also

as.alldiffs, allDifferences.data.frame, print.alldiffs, sort.alldiffs, facCombine.alldiffs, facRecode.alldiffs, renewClassify.alldiffs; fac.recode in package **dae**.

## Examples

```
    data("Ladybird.dat")

    ## Use asreml to get predictions and associated statistics

    ## Not run:
    m1.asr <- asreml(logitP ~ Host*Cadavers*Ladybird,
                     random = ~ Run,
                     data = Ladybird.dat)
    current.asrt <- as.asrtests(m1.asr)
    HCL.pred <- asreml::predict.asreml(m1.asr, classify="Host:Cadavers:Ladybird",
                                       sed=TRUE)
    HCL.preds <- HCL.pred$pvals
    HCL.sed <- HCL.pred$sed
    HCL.vcov <- NULL
    wald.tab <-  current.asrt$wald.tab
    den.df <- wald.tab[match("Host:Cadavers:Ladybird", rownames(wald.tab)), "denDF"]

  ## End(Not run)

    ## Use lmeTest and emmmeans to get predictions and associated statistics
    if (requireNamespace("lmerTest", quietly = TRUE) &
        requireNamespace("emmeans", quietly = TRUE))
    {
      m1.lmer <- lmerTest::lmer(logitP ~ Host*Cadavers*Ladybird + (1|Run),
                                data=Ladybird.dat)
      HCL.emm <- emmeans::emmeans(m1.lmer, specs = ~ Host:Cadavers:Ladybird)
      HCL.preds <- summary(HCL.emm)
      den.df <- min(HCL.preds$df)
      ## Modify HCL.preds to be compatible with a predictions.frame
      HCL.preds <- as.predictions.frame(HCL.preds, predictions = "emmean",
                                        se = "SE", interval.type = "CI",
                                        interval.names = c("lower.CL", "upper.CL"))
      HCL.vcov <- vcov(HCL.emm)
      HCL.sed <- NULL
    }

    ## Use the predictions obtained with either asreml or lmerTest
    if (exists("HCL.preds"))
    {
      ## Form an all.diffs object
     HCL.diffs <- as.alldiffs(predictions = HCL.preds, classify = "Host:Cadavers:Ladybird",
                              sed = HCL.sed, vcov = HCL.vcov, tdf = den.df)

      ## Check the class and validity of the alldiffs object
      is.alldiffs(HCL.diffs)
      validAlldiffs(HCL.diffs)

      ## Rename Cadavers
     HCL.diffs <- facRename(HCL.diffs, factor.names = "Cadavers", newnames = "Cadaver.nos")

      ## Check the validity of HCL.diffs
      validAlldiffs(HCL.diffs)
    }
```

getASRemlVersionLoaded

*Finds the version of asreml that is loaded and returns the initial characters in version.*

### Description

Checks that asreml is loaded and, if it is, returns the first nchar characters of the version that is loaded.

### Usage

```
getASRemlVersionLoaded(nchar = NULL, notloaded.fault = FALSE)
```

### Arguments

nchar          The number of characters in the asreml version to get.

notloaded.fault

          A [logical](#) indicating whether a fault is to occur if asreml is not loaded.

### Value

A character, being the first nchar characters of the version of asreml that is loaded.

### Author(s)

Chris Brien

### See Also

[loadASRemlVersion](#).

### Examples

```
## Not run:
getASRemlVersionLoaded()
## End(Not run)
```

getTestPvalue.asrtests

*Gets the p-value for a test recorded in the test.summary data.frame of an* [asrtests.object](#)

### Description

Matches the label in the term column of the supplied [asrtests.object](#) and extracts the its p-value. It only matches the first occurence of label.

## Usage

```
## S3 method for class 'asrtests'
getTestPvalue(asrtests.obj, label, ...)
```

## Arguments

| | |
|---|---|
| asrtests.obj | An asrtests.object containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary. |
| label | A character specifying the label of the test for which the p-value is required. If testranfix.asrtests was used for the test of interest, then the label will be the value of the term argument supplied to testranfix.asrtests. |
| ... | provision for passsing arguments to functions called internally - not used at present. |

## Value

An numeric containing the p-value. It can be NA, for example when a p-value could not be calculated.

## Author(s)

Chris Brien

## See Also

as.asrtests, testranfix.asrtests, testswapran.asrtests, testresidual.asrtests, changeTerms.asrtests, chooseModel.asrtests

## Examples

```
## Not run:
data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary(current.asrt)
# Test nugget term
current.asrt <- testranfix(current.asrt, "units", positive=TRUE)
getTestPvalue(current.asrt, label = "units")

## End(Not run)
```

---

infoCriteria.asreml        *Computes AIC and BIC for a model.*

---

## Description

Computes Akiake and Bayesian (Schwarz) Information Criteria for a model.

## Usage

```
## S3 method for class 'asreml'
infoCriteria(asreml.obj, DF = NULL,
             bound.exclusions = c("F","B","S","C"), ...)
```

## Arguments

asreml.obj       An asreml object resulting from the fitting of a model using REML.

DF               A numeric giving the number of estimated variance parameters. If NULL then
                 this is determined from the information in asreml.obj.

bound.exclusions

                 A character specifying the bound (constraint) codes that will result in a vari-
                 ance parameter being excluded from the count of estimated variance parameters.
                 If set to NULL then none will be excluded.

...              Provision for passsing arguments to functions called internally - not used at
                 present.

## Details

The degrees of freedom (DF) are the number of number of variance parameters that have been
estimated, excluding those whose estimates have a code for bound specified in bound.exclusions.
If DF is not NULL, the supplied value is used. Otherwise DF is determined from the information in
asreml.obj.

If ASReml-R version 4 is being used then the codes specified in bound.exclusions are not re-
stricted to a subset of the default codes, but a warning is issued if a code other than these is specified.
For ASReml-R version 3, only a subset of the default codes are allowed: F (Fixed), B (Boundary),
C (Constrained) and S (Singular).

The AIC is calculated as $-2 \times log(REML) + 2 \times DF$ and the BIC as $-2 \times log(REML) + DF \times (n - p)$, where $n$ is the number of observations and $r$ is the rank of the fixed effects design matrix.

## Value

A data frame containing the degrees of freedom, number of bound parameters, AIC, BIC and log of
the REML value.

## Author(s)

Chris Brien

## See Also

[REMLRT.asreml](REMLRT.asreml)

## Examples

```
## Not run:
   data(Wheat.dat)
   current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                         random = ~ Row + Column + units,
                         residual = ~ ar1(Row):ar1(Column),
                         data=Wheat.dat)
     infoCriteria(current.asr)
```

```
## End(Not run)
```

---

is.alldiffs                    *Tests whether an object is of class alldiffs*

---

### Description

A single-line `function` that tests whether an object is of `class alldiffs`.

### Usage

```
is.alldiffs(object)
```

### Arguments

object          An object to be tested.

### Value

A `logical`.

### Author(s)

Chris Brien

### See Also

[asremlPlus-package](#), [alldiffs.object](#), [is.alldiffs](#), [as.alldiffs](#)

### Examples

```
data(Oats.dat)

## Use lmerTest and emmmeans to get predictions and associated statistics
if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(Yield ~ Nitrogen*Variety + (1|Blocks/Wplots),
                            data=Oats.dat)
  Var.emm <- emmeans::emmeans(m1.lmer, specs = ~ Nitrogen:Variety)
  Var.preds <- summary(Var.emm)
  den.df <- min(Var.preds$df)
  ## Modify Var.preds to be compatible with a predictions.frame
  Var.preds <- as.predictions.frame(Var.preds, predictions = "emmean",
                                    se = "SE", interval.type = "CI",
                                    interval.names = c("lower.CL", "upper.CL"))
  Var.vcov <- vcov(Var.emm)
  Var.sed <- NULL

## Form an all.diffs object
 Var.diffs <- as.alldiffs(predictions = Var.preds, classify = "Nitrogen:Variety",
                          sed = Var.sed, vcov = Var.vcov, tdf = den.df)
```

```
## check the class of Var.diffs
is.alldiffs(Var.diffs)
}
```

---

is.asrtests                    *Tests whether an object is of class asrtests*

---

### Description

A single-line function that tests whether an object is of class asrtests.

### Usage

```
is.asrtests(object)
```

### Arguments

object          An object to be tested.

### Value

A logical.

### Author(s)

Chris Brien

### See Also

[asremlPlus-package](#), [asrtests.object](#), [is.asrtests](#), [as.asrtests](#)

### Examples

```
## Not run:
library(dae)
library(asreml)
library(asremlPlus)
## use ?Wheat.dat for data set details
data(Wheat.dat)

# Fit initial model
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)

# Load current fit into an asrtests object
current.asrt <- as.asrtests(current.asr, NULL, NULL)

# check the class of current.asrt
is.asrtests(current.asrt)

## End(Not run)
```

is.predictions.frame    *Tests whether an object is of class predictions.frame*

### Description

A single-line `function` that tests whether an object is of `class predictions.frame`.

### Usage

```
is.predictions.frame(object)
```

### Arguments

object          An object to be tested.

### Value

A `logical`.

### Author(s)

Chris Brien

### See Also

[asremlPlus-package](#), [predictions.frame](#), [is.predictions.frame](#), [as.predictions.frame](#)

### Examples

```
data(Oats.dat)

## Use asreml to get predictions and associated statistics

## Not run:
m1.asr <- asreml(Yield ~ Nitrogen*Variety,
                 random=~Blocks/Wplots,
                 data=Oats.dat)
current.asrt <- as.asrtests(m1.asr)
Var.pred <- asreml::predict.asreml(m1.asr, classify="Nitrogen:Variety",
                                   sed=TRUE)
if (getASRemlVersionLoaded(nchar = 1) == "3")
  Var.pred <- Var.pred$predictions
Var.preds <- as.predictions.frame(Var.pred$pvals, se = "std.error",
                                  est.status = "status")

## End(Not run)

## Use lmerTest and emmmeans to get predictions and associated statistics
if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(Yield ~ Nitrogen*Variety + (1|Blocks/Wplots),
                            data=Oats.dat)
  Var.emm <- emmeans::emmeans(m1.lmer, specs = ~ Nitrogen:Variety)
```

```
      Var.preds <- summary(Var.emm)
      Var.preds <- as.predictions.frame(Var.preds, predictions = "emmean",
                                   se = "SE", interval.type = "CI",
                                   interval.names = c("lower.CL", "upper.CL"))
  }

  if (exists("Var.preds"))
  {
    ## Check the class and validity of the alldiffs object
    is.predictions.frame(Var.preds)
  }
```

| Ladybird.dat | *Data for an experiment to investigate whether ladybirds transfer aphids* |
|---|---|

### Description

Welham et al. (2015, Example 8.2) describe a three-factor factorial experiment to investigate whether ladybirds transfer fungus to live aphids on plants. The three factors are Host plant (beans, trefoil), infected Cadavers (5, 10, 20), and Ladybird (-, +). A generalized randomized complete-block design is used to assign the three factors to 2 Runs, each of which involves 36 containers with a plant and live aphids. The response to be analyzed is the logit of the proportion of live aphids that were infected.

The columns in the data frame are: ID, Run, Plant, Host, Ladybird, Cadavers, Live, Infected, logitP, Prop. The column ID numbers the observations. Live, Infected, logitP, Prop are response variables.

### Usage

```
data(Ladybird.dat)
```

### Format

A data.frame containing 72 observations of 10 variables.

### Author(s)

Chris Brien

### Source

Welham, S. J., Gezan, S. A., Clark, S. J., \& Mead, A. (2015). *Statistical Methods in Biology: Design and Analysis of Experiments and Regression*. Boca Raton: Chapman and Hall/CRC..

---

linTransform.alldiffs *Calculates a linear transformation of the predictions stored in an* alldiffs.object*.*

---

## Description

Effects the linear transformation of the predictions in the supplied alldiffs.object, the transformation being specified by a matrix or a formula. The values of the transformed values are stored in an alldiffs.object. A matrix might be a contrast matrix or a matrix of weights for the levels of a factor used to obtain the weighted average over the levels of that factor. A formula gives rise to a projection matrix that linearly transforms the predictions so that they conform to the model specified by the formula, this model being a submodel of that inherent in the classify.

If pairwise = TRUE, all pairwise differences between the linear transforms the predictions, their standard errors, p-values and LSD statistics are computed as using allDifferences.data.frame. This adds them to the alldiffs.object as additional list components named differences, sed, p.differences and LSD.

If a transformation has been applied (any one of transform.power is not one, scale is not one and offset is nonzero), the backtransforms of the transformed values and their lower and upper confidence intervals are added to a data.frame that is consistent with a predictions.frame. If transform.power is other than one, the standard.error column of the data.frame is set to NA. This data.frame is added to the alldiffs.object as a list component called backtransforms.

The printing of the components produced is controlled by the tables argument. The order of plotting the levels of one of the factors indexing the predictions can be modified and is achieved using sort.alldiffs.

## Usage

```
## S3 method for class 'alldiffs'
linTransform(alldiffs.obj, classify = NULL, term = NULL,
             linear.transformation = NULL, Vmatrix = FALSE,
             error.intervals = "Confidence", avsed.tolerance = 0.25,
             meanLSD.type = "overall", LSDby = NULL,
             response = NULL, response.title = NULL,
             x.num = NULL, x.fac = NULL,
             tables = "all", level.length = NA,
             pairwise = TRUE, alpha = 0.05,
             inestimable.rm = TRUE, ...)
```

## Arguments

alldiffs.obj    An alldiffs.object.

classify        A character string giving the variables that define the margins of the multiway table to be predicted. Multiway tables are specified by forming an interaction type term from the classifying variables, that is, separating the variable names with the : operator.

term            A character string giving the variables that define the term that was fitted using asreml and that corresponds to classify. It only needs to be specified when it is different to classify.

linear.transformation

A [formula](#) or a [matrix](#). If a [formula](#) is given then it is taken to be a submodel of the model term corresponding to the classify. The projection matrix that transforms the predictions so that they conform to the submodel is obtained; the submodel should involving the variables in the classify. For example, for classify set to "A:B", the submodel ~ A + B will result in the predictions for the combinations of A and B being made additive for the [factor](#)s A and B.

If a [matrix](#) is provided then it will be used to apply the linear transformation to the predictions. The number of rows in the [matrix](#) should equal the number of linear combinations of the predictions desired and the number of columns should equal the number of predictions.

In either case, as well as the values of the linear combinations, their standard errors, pairwise differences and associated statistics are returned.

Vmatrix             A [logical](#) indicating whether the variance matrix of the predictions will be stored as a component of the [alldiffs.object](#) that is returned. If linear.transformation is set, it will be stored irrespective of the value of Vmatrix.

error.intervals

A [character](#) string indicating the type of error interval, if any, to calculate in order to indicate uncertainty in the results. Possible values are "none", "StandardError", "Confidence" and "halfLeastSignificant". The default is for confidence limits to be used. The "halfLeastSignificant" option results in half the Least Significant Difference (LSD) being added and subtracted to the predictions, the LSD being calculated using the square root of the mean of the variances of all or a subset of pairwise differences between the predictions. If meanLSD.type is set to overall, the avsed.tolerance is not NA and the range of the SEDs divided by the average of the SEDs exceeds avsed.tolerance then the error.intervals calculations and the plotting will revert to confidence intervals.

avsed.tolerance

A [numeric](#) giving the value of the SED range, the range of the SEDs divided by the square root of the mean of the variances of all or a subset of the pairwise differences, that is considered reasonable in calculating error.intervals. It should be a value between 0 and 1. The following rules apply:

1. If avsed.tolerance is NA then mean LSDs of the type specified by meanLSD.type are calculated and used in error.intervals and plots.
2. Irrespective of the setting of meanLSD.type, if avsed.tolerance is not exceeded then the mean LSDs are used in error.intervals and plots.
3. If meanLSD.type is set to overall, avsed.tolerance is not NA, and avsed.tolerance is exceeded then error.intervals and plotting revert to confidence intervals.
4. If meanLSD.type is set to factor.combinations and avsed.tolerance is not exceeded for any factor combination then the half LSDs are used in error.intervals and plots; otherwise, error.intervals and plotting revert to confidence intervals.
5. If meanLSD.type is set to per.prediction and avsed.tolerance is not exceeded for any prediction then the half LSDs are used in error.intervals and plots; otherwise, error.intervals and plotting revert to confidence intervals.

meanLSD.type       A [character](#) string determining whether the mean LSD stored is (i) the overall mean, based on the square root of the mean of the variances of all pairwise variances, (ii) the mean for each factor.combination of the [factor](#)s specified by

LSDby, which is based on the square root of the mean of the variances for all pairwise differences for each factor combination, or (iii) the per.prediction mean, based, for each prediction, on the square root of the mean of the variances for all pairwise differences involving that prediction, unless there is only one prediction for a factor.combination, when notional LSDs are calculated that are based on the standard error of the prediction multiplied by the square root of two. It also determines, in conjunction with avsed.tolerance, which LSD will be used in calculating error.intervals and, hence, is used for plots.

LSDby            A character (vector) of variables names, being the names of the factors or numerics in the classify for each combination of which a mean LSD, minLSD and max LSD is stored in the LSD component of the alldiffs.object when meanLSD.type is factor.combinatons.

response         A character specifying the response variable for the predictions. It is stored as an attribute to the alldiffs.object .

response.title   A character specifying the title for the response variable for the predictions. It is stored as an attribute to the alldiffs.object.

x.num            A character string giving the name of the numeric covariate that (i) corresponds to x.fac, (ii) is potentially included in terms in the fitted model, and (iii) which corresponds to the x-axis variable. It should have the same number of unique values as the number of levels in x.fac.

x.fac            A character string giving the name of the factor that (i) corresponds to x.num, (ii) is potentially included in terms in the fitted model, and (iii) which corresponds to the x-axis variable. It should have the same number of levels as the number of unique values in x.num. The levels of x.fac must be in the order in which they are to be plotted - if they are dates, then they should be in the form yyyymmdd, which can be achieved using as.Date. However, the levels can be non-numeric in nature, provided that x.num is also set.

tables           A character vector containing a combination of none, predictions, vcov, backtransforms, differences, p.differences, sed, LSD and all. These nominate which components of the alldiffs.object to print.

level.length     The maximum number of characters from the the levels of factors to use in the row and column labels of the tables of pairwise differences and their p-values and standard errors.

pairwise         A logical indicating whether all pairwise differences of the predictions and their standard errors and p-values are to be computed and stored. If tables is equal to "differences" or "all" or error.intervals is equal to "halfLeastSignificant", they will be stored irrespective of the value of pairwise.

alpha            A numeric giving the significance level for LSDs or one minus the confidence level for confidence intervals.

inestimable.rm   A logical indicating whether rows for predictions that are not estimable are to be removed from the components of the alldiffs.object.

...              further arguments passed to redoErrorIntervals.alldiffs.

## Details

For a matrix $\mathbf{L}$, vector of predictions $\mathbf{p}$ and variance matrix of the predictions $\mathbf{V}_p$, the linear transformed predictions are given by $\mathbf{Lp}$ with variance matrix $\mathbf{LV}_p\mathbf{L}^{\mathrm{T}}$. The last matrix is used to compute the variance of pairwise differences between the transformed values.

The matrix $\mathbf{L}$ is directly specified by setting linear.transformation to it. If linear.transformation is a formula then $\mathbf{L}$ is formed as the sum of the orthogonal projection matrices obtained using

pstructure.formula from the package dae; grandMean is set to TRUE and orthogonalize to "eigenmethods".

## Value

A [alldiffs.object](#) with the linear transformation of the predictions and their standard errors and all pairwise differences between the linear transforms of their predictions, their standard errors and p-values and LSD statistics.

If the supplied [alldiffs.object](#) contained a backtransforms componnent, then the returned [alldiffs.object](#) will contain a backtransforms component with the backtransformed linear transformation of the predictions. The backtransformation will, after backtransforming for any power transformation, subtract the offset and then divide by the scale.

If error.intervals is not "none", then the predictions component and, if present, the backtransforms component will contain columns for the lower and upper values of the limits for the interval. The names of these columns will consist of three parts separated by full stops: 1) the first part will be lower or upper; 2) the second part will be one of Confidence, StandardError or halfLeastSignificant; 3) the third component will be limits.

The name of the response, the response.title, the term, the classify, tdf, sortFactor and the sortOrder will be set as attributes to the object.

## Author(s)

Chris Brien

## See Also

[predictPlus.asreml](#), [as.alldiffs](#), [print.alldiffs](#), [sort.alldiffs](#), [subset.alldiffs](#), [allDifferences.data.frame](#), [redoErrorIntervals.alldiffs](#), [recalcLSD.alldiffs](#), [predictPresent.asreml](#), [plotPredictions.data.frame](#), as.Date, predict.asreml

## Examples

```
data(WaterRunoff.dat)

##Use asreml to get predictions and associated statistics

## Not run:
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = pH ~ Benches + (Sources * (Type + Species)),
                      random = ~ Benches:MainPlots,
                      keep.order=TRUE, data= WaterRunoff.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
#Get additive predictions directly using predictPlus
diffs.sub <- predictPlus.asreml(classify = "Sources:Species", Vmatrix = TRUE,
                                linear.transformation = ~ Sources + Species,
                                asreml.obj = current.asr, tables = "none",
                                wald.tab = current.asrt$wald.tab,
                                present = c("Type","Species","Sources"))

## End(Not run)

## Use lmeTest and emmmeans to get predictions and associated statistics

if (requireNamespace("lmerTest", quietly = TRUE) &
```

```
      requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(pH ~ Benches + (Sources * Species) +
                              (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  SS.emm <- emmeans::emmeans(m1.lmer, specs = ~ Sources:Species)
  SS.preds <- summary(SS.emm)
  den.df <- min(SS.preds$df, na.rm = TRUE)
  ## Modify SS.preds to be compatible with a predictions.frame
  SS.preds <- as.predictions.frame(SS.preds, predictions = "emmean",
                                   se = "SE", interval.type = "CI",
                                   interval.names = c("lower.CL", "upper.CL"))

  ## Form an all.diffs object and check its validity
  SS.vcov <- vcov(SS.emm)
  SS.diffs <- allDifferences(predictions = SS.preds, classify = "Sources:Species",
                             vcov = SS.vcov, tdf = den.df)
  validAlldiffs(SS.diffs)

  #Get additive predictions
  diffs.sub <- linTransform(SS.diffs, classify = "Sources:Species",
                            linear.transformation = ~ Sources + Species,
                            Vmatrix = TRUE, tables = "none")
}

##Calculate contrasts from prediction obtained using asreml or lmerTest
if (exists("diffs.sub"))
{
 #Contrast matrix for differences between each species and non-planted for the last source
 L <- cbind(matrix(rep(0,7*32), nrow = 7, ncol = 32),
            diag(1, nrow = 7),
            matrix(rep(-1, 7), ncol = 1))
 rownames(L) <- as.character(diffs.sub$predictions$Species[33:39])
 diffs.L <- linTransform(diffs.sub,
                         classify = "Sources:Species",
                         linear.transformation = L,
                         tables = "predictions")
}
```

---

loadASRemlVersion            *Ensures that a specific version of* asreml *is loaded.*

---

## Description

Loads the specified version of asreml, provided that it is not already loaded. If the version of asreml is not the required version, then the loaded version is unloaded first.

## Usage

```
loadASRemlVersion(version = 4, ...)
```

## Arguments

| | |
|---|---|
| version | The version that is to be loaded, the vesion consisting of just the initial characters that are significant in the version that should be loaded. For example, the default value of 4 implies that any version that begins with "4" is acceptable. It is used to check that the required version is loaded. |
| ... | Other library/require arguments that are needed to load the specified version of asreml. |

## Value

A character, being all characters in the version of asreml that is loaded on exit from the function.

## Author(s)

Chris Brien

## See Also

[getASRemlVersionLoaded](#).

## Examples

```
## Not run:
loadASRemlVersion(3, lib.loc = "D:\Analyses\R asreml3")
## End(Not run)
```

---

| | |
|---|---|
| newfit.asreml | *Refits an asreml model with modified model formula using either a call to* update.asreml *or a direct call to* asreml. |

---

## Description

Extracts the call from the asreml.obj and evaluates that call, replacing any arguments with changed values. If update is TRUE and set.terms is not set, the call is evaluated using update.asreml; otherwise, it is evaluated using a direct call to asreml. The principal difference is that the latter does not enforce the use of previous values of the variance parameters as initial values; it sets G.param and R.param to NULL or to values as specified for set.terms. The ... argument can be used to pass G.param and/or R.param, provided update is FALSE and set.terms is not set.

## Usage

```
## S3 method for class 'asreml'
newfit(asreml.obj, fixed., random., sparse.,
       residual., rcov., update = TRUE,
       allow.unconverged = TRUE, keep.order = TRUE,
       set.terms = NULL, ignore.suffices = TRUE, bounds = "P",
       initial.values = NA, ...)
```

**Arguments**

|  |  |
|---|---|
| asreml.obj | A valid asreml object with with a component named call (from a previous call to either asreml or update.asreml). |
| fixed. | A character or formula specifying changes to the fixed formula. This is a two-sided formula where "." is substituted for existing components in the fixed component of asreml.obj$call. |
| random. | A character or formula specifying changes to the random formula. This is a one-sided formula where "." is substituted for existing components in the random component of asreml.obj$call. |
| sparse. | A character or formula specifying changes to the sparse formula. This is a one-sided formula where "." is substituted for existing components in the sparse component of asreml.obj$call. |
| residual. | A character or formula specifying changes to the error formula, used when version 4 or later of ASReml-R is loaded. This is a one-sided formula where "." is substituted for existing components in the residual component of asreml.obj$call. |
| rcov. | A character or formula specifying changes to the error formula, used when version 3 of ASReml-R is loaded. This is a one-sided formula where "." is substituted for existing components in the residual component of asreml.obj$call. |
| update | A logical indicated whether to use update.asreml or asreml to evaluate the modified call. If TRUE, use update.asreml to evaluate the modified call. In doing this the arguments R.param and G.param are set to those in the asreml.obj so that the values from the previous model are used as starting values. If FALSE then a call is made to asreml itself, in which the only changes from the previous call are those specified in the arguments to newfit.asreml. |
| allow.unconverged | |
| | A logical indicating whether to accept a new model even when it does not converge. If FALSE and the fit does not converge, the supplied asreml object is returned. |
| keep.order | A logical value indicating whether the terms should keep their positions. If FALSE the terms are reordered so that main effects come first, followed by the interactions, all second-order, all third-order and so on. Effects of a given order are kept in the order specified. |
| set.terms | A character vector specifying the terms that are to have bounds and/or initial values set prior to fitting. |
| ignore.suffices | |
| | A logical vector specifying whether the suffices of the asreml-assigned names of the variance terms (i.e. the information to the right of an "!", other than "R!") is to be ignored in matching elements of terms. If TRUE for an element of terms, the suffices are stripped from the asreml-assigned names. If FALSE for an element of terms, the element must exactly match an asreml-assigned name for a variance term. This vector must be of length one or the same length as terms. If it is of length one then the same action is applied to the asreml-assigned suffices for all the terms in terms. |
| bounds | A [character](#) vector specifying the bounds to be applied to the terms specified in set.terms. This vector must be of length one or the same length as set.terms. If it is of length one then the same constraint is applied to all the terms in set.terms. If any of the bounds are equal to NA then they are left unchanged for those terms. |

|  |  |
|---|---|
| initial.values | A character vector specifying the initial values for the terms specified in terms. This vector must be of length one or the same length as terms. If it is of length one then the same initial value is applied to all the terms in terms. If any of the initial.values are equal to NA then they are left unchanged for those terms. |
| ... | additional arguments to the call, or arguments with changed values. |

## Value

An asreml object.

## Author(s)

Chris Brien

## References

Butler, D. G., Cullis, B. R., Gilmour, A. R., Gogel, B. J. and Thompson, R. (2018). *ASReml-R Reference Manual Version 4.* VSN International Ltd, http://asreml.org.

## See Also

update.asreml, setvarianceterms.call

## Examples

```
## Not run:
    m2.asreml <- newfit(m1.asreml, random. = "~ . - Blocks:Plots", maxiter=75)

## End(Not run)
```

---

| num.recode | *Recodes the unique values of a vector using the values in a new vector.* |
|---|---|

---

## Description

Recodes the unique values of a variate using the value in position i of the new.values vector to replace the ith sorted unique values of x. The new levels do not have to be unique.

## Usage

```
num.recode(x, new.values)
```

## Arguments

|  |  |
|---|---|
| x | The vector to be recoded. |
| new.values | A vector of length unique(x) containing values to use in the recoding. |

## Value

A vector.

**Author(s)**

Chris Brien

**See Also**

`dae::fac.recode`.

**Examples**

```
## set up a factor with labels
x <- rep(c(-42, -14, 14, 42), 4)

## recode x
b <- num.recode(x, c(0, 28, 56, 84))
```

---

| Oats.dat | *Data for an experiment to investigate nitrogen response of 3 oats varieties* |
|---|---|

---

**Description**

Yates (1937) describes a split-plot experiment that investigates the effects of three varieties of oats and four levels of Nitrogen fertilizer. The varieties are assigned to the main plots using a randomized complete block design with 6 blocks and the nitrogen levels are randomly assigned to the subplots in each main plot.

The columns in the data frame are: Blocks, Wplots, Subplots, Variety, Nitrogen, xNitrogen, Yield. The column xNitrogen is a numeric version of the factor Nitrogen. The response variable is Yield.

**Usage**

```
data(Oats.dat)
```

**Format**

A data.frame containing 72 observations of 7 variables.

**Author(s)**

Chris Brien

**Source**

Yates, F. (1937). The Design and Analysis of Factorial Experiments. *Imperial Bureau of Soil Science, Technical Communication*, **35**, 1-95.

---

permute.square *Permutes the rows and columns of a square matrix.*

---

### Description

Permutes the rows and columns of a square matrix.

### Usage

```
permute.square(x, permutation)
```

### Arguments

x               A square matrix.

permutation     A vector specifying the new order of rows and columns.

### Value

A square `matrix`.

### Author(s)

Chris Brien

### See Also

[permute.to.zero.lowertri](permute.to.zero.lowertri)

### Examples

```
terms.marginality <-  matrix(c(1,0,0,0,0,  0,1,0,0,0, 0,1,1,0,0,
                               1,1,1,1,0, 1,1,1,1,1), nrow=5)
permtn <- c(1,3,2,4,5)
terms.marginality <- permute.square(terms.marginality, permtn)
```

---

permute.to.zero.lowertri

*Permutes a square matrix until all the lower triangular elements are zero.*

---

### Description

Permutes a square matrix until all the lower triangular elements are zero.

### Usage

```
permute.to.zero.lowertri(x)
```

### Arguments

x               A square matrix of order n with at least n*(n-1)/2 zero elements.

## Value

A square `matrix`.

## Author(s)

Chris Brien

## See Also

[permute.square](#)

## Examples

```
terms.marginality <-  matrix(c(1,0,0,0,0,  0,1,0,0,0, 0,1,1,0,0,
                               1,1,1,1,0, 1,1,1,1,1), nrow=5)
terms.marginality <- permute.to.zero.lowertri(terms.marginality)
```

---

plotPredictions.data.frame

*Plots the predictions for a term, possibly with error bars.*

---

## Description

This function plots the predictions y that are based on `classify` and stored in the `data.frame` `data`. The package ggplot2 is used to produce the plots. Line plots are produced when variables involving `x.num` or `x.fac` are involved in `classify` for the predictions; otherwise, bar charts are produced. Further, for line charts, the argument `panels` determines whether a single plot or multiple plots in a single window are produced; for bar charts, the argument `panels` is ignored.

## Usage

```
## S3 method for class 'data.frame'
plotPredictions(data, classify, y,
                x.num = NULL, x.fac = NULL, nonx.fac.order = NULL,
                colour.scheme = "colour", panels = "multiple",
                graphics.device = NULL,
                error.intervals = "Confidence",  titles = NULL,
                y.title = NULL, filestem = NULL, ggplotFuncs = NULL, ...)
```

## Arguments

data            A [predictions.frame](#), or data.frame, containing the values of the variables
                to be plotted. Generally, it should contain the variables classifying the predic-
                tions and include a column with the name specified in the y argument, usu-
                ally predicted.value or backtransformed.predictions; each row contains
                a single predicted value. It should also include columns for the standard.error
                and est.status. The number of rows should equal the number of unique com-
                binations of the classifying variables. While such a data.frame can be con-
                structed from the beginning, the pvals component of the value produced by
                predict.asreml is a suitable value to supply for this argument. Note that the
                names standard.error and est.status have been changed to std.error and

status in the pvals component produced by asreml-R4; if the new names are in the data.frame supplied to predictions, they will be returned to the previous names.

If error.intervals is not "none", then the predictions component and, if present, the backtransforms component should contain columns for the lower and upper values of the limits for the interval with names that begin with lower and upper, respectively. The second part of the name must be one of Confidence, StandardError or halfLeastSignificant. The last part needs to be consistent between the lower and upper limits.

classify    A character string giving the combinations of the independent variables on which the predictions are based. It is an interaction type term formed from the independent variables, that is, separating the variable names with the : operator. To predict the overall mean, set the classify to "(Intercept)".

y           A character string giving the name of the variable that is to be plotted on the Y axis.

x.num       A character string giving the name of the numeric covariate that corresponds to x.fac, is potentially included in terms in the fitted model and which corresponds to the x-axis variable. It should have the same number of unique values as the number of levels in x.fac.

x.fac       A character string giving the name of the factor that corresponds to x.num, is potentially included in terms in the fitted model and which corresponds to the x-axis variable. It should have the same number of levels as the number of unique values in x.num. The levels of x.fac must be in the order in which they are to be plotted - if they are dates, then they should be in the form yyyymmdd, which can be achieved using as.Date. However, the levels can be non-numeric in nature, provided that x.num is also set.

nonx.fac.order  A character vector giving the order in which factors other than x.fac are to be plotted in facetted plots (i.e. where the number of non x factors is greater than 1). The first factor in the vector will be plotted on the X axis (if there is no x.num or x.fac. Otherwise, the order of plotting the factors is in columns (X facets) and then rows (Y facets). By default the order is in decreasing order for the numbers of levels of the non x factors.

colour.scheme   A character string specifying the colour scheme for the plots. The default is "colour" which produces coloured lines and bars, a grey background and white gridlines. A value of "black" results in black lines, grey bars and gridlines and a white background.

panels      Possible values are "single" and "multiple". When line plots are to be produced, because variables involving x.num or x.fac are involved in classify for the predictions, panels determines whether or not a single panel or multiple panels in a single window are produced. The panels argument is ignored for bar charts.

graphics.device

A character specifying a graphics device for plotting. The default is graphics.device = NULL, which will result in plots being produced on the current graphics device. Setting it to "windows", for example, will result in a windows graphics device being opened.

error.intervals

A character string indicating the type of error interval, if any, to plot in order to indicate uncertainty in the results. Possible values are "none", "StandardError", "Confidence" and "halfLeastSignificant". Here, any option other than "none" will result in the interval limits contained in data being plotted.

titles          A `list`, each component of which is named for a column in the `data.frame`
                for the `asreml.obj` used in making the predictions and contains a `character`
                `string` giving a title to use in output (e.g. tables and graphs). Here they will be
                used for axis labels for nonresponse variables. For response variable labels see
                `y.title`.

filestem        A character sting giving the beginning of the name of the file in which to save
                the plot. If `filestem = NULL`, the plot is not saved. The remainder of the file
                name will be generated automatically and consists of the following elements
                separated by full stops: the classify term, `Bar` or `Line` and, if `error.intervals`
                is not `"none"`, one of `SE`, `CI` or `LSI`. The file will be saved as a 'png' file in the
                current work directory.

y.title         The title to be displayed on the y axis of any plot.

ggplotFuncs     A [list](), each element of which contains the results of evaluating a [ggplot]() func-
                tion. It is created by calling the [list]() function with a [ggplot]() function call for
                each element.

...             further arguments passed to ggplot.

## Value

no values are returned.

## Author(s)

Chris Brien

## See Also

[allDifferences.data.frame](), [predictPresent.asreml](), [redoErrorIntervals.alldiffs](),
[recalcLSD.alldiffs](), ggplot, Devices

## Examples

```
## Not run:
data(WaterRunoff.dat)
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = log.Turbidity ~ Benches + Sources + Type + Species +
                                Sources:Type + Sources:Species +
                                Sources:xDay + Species:xDay + Species:Date,
                      data = WaterRunoff.dat, keep.order = TRUE)
current.asrt <- as.asrtests(current.asr, NULL, NULL)

#### Get the observed combinations of the factors and variables in classify
class.facs <- c("Species","Date","xDay")
levs <- as.data.frame(table(WaterRunoff.dat[class.facs]))
levs <- as.list(levs[levs$Freq != 0, class.facs])
levs$xDay <- as.numfac(levs$xDay)

predictions <- predict(current.asr, classify="Species:Date:xDay",
                       parallel = TRUE, levels = levs,
                       present = c("Type","Species","Sources"))
#### for asreml-R3
predictions <- predictions$predictions$pvals
predictions <- predictions[predictions$est.status == "Estimable",]
#### for asreml-R4
```

```
predictions <- predictions$pvals
predictions <- predictions[predictions$status == "Estimable",]
#### end
plotPredictions(classify="Species:Date:xDay", y = "predicted.value",
                data = predictions,
                x.num = "xDay", x.fac = "Date",
                x.title = "Days since first observation",
                y.title = "Predicted log(Turbidity)",
                present = c("Type","Species","Sources"),
                error.intervals = "none",
                ggplotFuncs = list(ggtitle("Transformed turbidity over time")))

diffs <- predictPlus(classify="Species:Date:xDay",
                     present=c("Type","Species","Sources"),
                     asreml.obj = current.asr, tables = "none",
                     x.num = "xDay", x.fac = "Date",
                     parallel = TRUE, levels = levs,
                     x.plot.values=c(0,28,56,84),
                     wald.tab = current.asrt$wald.tab)
x.title <- "Days since first observation"
names(x.title) <- "xDay"
plotPredictions(classify="Species:Date:xDay", y = "predicted.value",
                data = diffs$predictions,
                x.num = "xDay", x.fac = "Date",
                titles = x.title,
                y.title = "Predicted log(Turbidity)")

## End(Not run)

## Use lmerTest and emmmeans to get predictions and associated statistics
if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  data(Ladybird.dat)
  m1.lmer <- lmerTest::lmer(logitP ~ Host*Cadavers*Ladybird + (1|Run),
                            data=Ladybird.dat)
  HCL.emm <- emmeans::emmeans(m1.lmer, specs = ~ Host:Cadavers:Ladybird)
  HCL.preds <- summary(HCL.emm)
  den.df <- min(HCL.preds$df)
  ## Modify HCL.preds to be compatible with a predictions.frame
  HCL.preds <- as.predictions.frame(HCL.preds, predictions = "emmean",
                                    se = "SE", interval.type = "CI",
                                    interval.names = c("lower.CL", "upper.CL"))
  ## Plot the predictions
  plotPredictions(HCL.preds, y = "predicted.value", "Host:Cadavers:Ladybird")
}
```

---

| plotPvalues.alldiffs | *Plots a heat map of p-values for pairwise differences between predictions.* |
|---|---|

---

## Description

Produces a heat-map plot of the p-values for pairwise differences between predictions that is stored in the p.differences component of an all.diffs object. This is generally a matrix whose rows

and columns are labelled by the levels of one or more factors, the set of labels being the same for rows and columns. The `sections` argument allows multiple plots to be produced, one for each combination of the levels of the factors listed in `sections`. Otherwise, a single plot is produced for all observed combinations of the levels of the factors in the `classify` for the `alldiffs.object`. The plots are produced using `plotPvalues.data.frame`. The order of plotting the levels of one of the factors indexing the predictions can be modified and is achieved using `sort.alldiffs`.

## Usage

```
plotPvalues(object, ...)
## S3 method for class 'alldiffs'
plotPvalues(object, sections = NULL,
            gridspacing = 0, factors.per.grid = 0,
            show.sig = FALSE, triangles = "both",
            title = NULL, axis.labels = TRUE, sep=",",
            colours = RColorBrewer::brewer.pal(3, "Set2"),
            ggplotFuncs = NULL, printPlot = TRUE,
            sortFactor = NULL, sortWithinVals = NULL,
            sortOrder = NULL, decreasing = FALSE, ...)
```

## Arguments

object   An `alldiffs.object` with a `p.differences` component that is not NULL.

sections   A `character` listing the names of the factors that are to be used to break the plot into sections. A separate plot will be produced for each observed combination of the levels of these factors.

gridspacing  A `numeric` specifying the number(s) of rows and columns that form groups in the grid of differences. An alternative is to specify the `factors.per.grid` argument to have the grid spacings automatically calculated. Grids are most useful when two or more factors index the rows and columns. If a single, nonzero number, *k* say, is given then a grid line is placed after every *k*th row and column. If a vector of values is given then the number of grid lines is the length of the vector and the spacing between each is specified by the elements of the vector.

factors.per.grid

     A `numeric` specifying the number of factors to include within each grid of differences. The `gridspacing` will then be computed based on the numbers of combinations observed within the levels of the remaining factors in a single plot. The `gridspacing` argument to this function will be ignored if `factors.per.grid` is greater than zero. Grids are most useful when two or more factors index the rows and columns of each plot.

show.sig   A `logical` that specifies whether asterisks indicating the level of significance are to be added to the plot. If they are then '***' indicates that $p \leq 0.001$, '**' that $0.001 < p \leq 0.01$, '*' that $0.01 < p \leq 0.05$ '.' that $0.05 < p \leq 0.10$.

triangles   A `character` indicating whether the plot should include the `lower`, `upper` or `both` traingle(s).

title    A `character` string giving the main title for the plot and to which is appended the levels combination of the sectioning factors, if any, for each plot.

axis.labels  A `logical` indicating whether a label is to be added to the x- and y-axes. If TRUE, the label is the comma-separated list of factors whose levels combinations are involved in the prediction differences for which the p-values are calculated.

| | |
|---|---|
| colours | A vector of of colours to be passed to the ggplot function scale_colour_gradientn. |
| sep | A character giving the characters separating the levels of different factors in the row and column names of the p.differences component. |
| ggplotFuncs | A [list](#), each element of which contains the results of evaluating a [ggplot](#) function. It is created by calling the [list](#) function with a [ggplot](#) function call for each element. It is passed to ggplot via [plotPvalues.data.frame](#). |
| printPlot | A logical indicating whether or not the a plot is to be printed. This would be used when just the returned data.frame is required. |
| sortFactor | A character containing the name of the factor that indexes the set of predicted values that determines the sorting of the components of the [alldiffs.object](#) by [sort.alldiffs](#). If NULL then sorting is not carried out. If there is more than one variable in the classify term then sortFactor is sorted for the predicted values within each combination of the values of the sortWithin variables: the classify variables, excluding the sortFactor. There should be only one predicted value for each unique value of sortFactor within each set defined by a combination of the values of the sortWithin variables. |
| sortWithinVals | A list with a component named for each factor and numeric that is a classify variable for the predictions, excluding sortFactor. Each component should contain a single value that is a value of the variable. The combination of this set of values will be used to define a subset of the predicted values whose order will define the order of sortFactor to be used for all combinations of the sortWithinVals variables. If sortWithinVals is NULL then the first value of each sortWithin variable in predictions component is used to define sortWithinVals. If there is only one variable in the classify then sortWithinVals is ignored. |
| sortOrder | A character vector whose length is the same as the number of levels for sortFactor in the predictions component of the [alldiffs.object](#). It specifies the desired order of the levels in the reordered components of the [alldiffs.object](#). The argument sortWithinVals is ignored.<br><br>The following creates a sortOrder vector levs for factor f based on the values in x: levs <-levels(f)[order(x)]. |
| decreasing | A logical passed to order that detemines whether the order for sorting the [alldiffs.object](#) components is for increasing or decreasing magnitude of the predicted values. |
| ... | Provision for passsing arguments to functions called internally - not used at present. |

## Value

A data.frame with the columns X1, X2, p, sections1 and sections2. This data.frame is formed from the p.differences component of object and is used in producng the plot.

## Author(s)

Chris Brien

## See Also

[plotPvalues.data.frame](#), [allDifferences.data.frame](#), [sort.alldiffs](#), [subset.alldiffs](#), ggplot

## Examples

```
data(WaterRunoff.dat)

##Use asreml to get predictions and associated statistics

## Not run:
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = pH ~ Benches + (Sources * (Type + Species)),
                      random = ~ Benches:MainPlots,
                      keep.order=TRUE, data= WaterRunoff.dat))
current.asrt <- as.asrtests(current.asr, NULL, NULL)
SS.diffs <- predictPlus.asreml(classify = "Sources:Type",
                                asreml.obj = current.asr, tables = "none",
                                wald.tab = current.asrt$wald.tab,
                                present = c("Type","Species","Sources"))

## End(Not run)

## Use lmeTest and emmmeans to get predictions and associated statistics

if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(pH ~ Benches + (Sources * (Type + Species)) +
                             (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  TS.emm <- emmeans::emmeans(m1.lmer, specs = ~ Sources:Species)
  TS.preds <- summary(TS.emm)
  den.df <- min(TS.preds$df, na.rm = TRUE)
  ## Modify TS.preds to be compatible with a predictions.frame
  TS.preds <- as.predictions.frame(TS.preds, predictions = "emmean",
                                    se = "SE", interval.type = "CI",
                                    interval.names = c("lower.CL", "upper.CL"))

  ## Form an all.diffs object and check its validity
  TS.vcov <- vcov(TS.emm)
  TS.diffs <- allDifferences(predictions = TS.preds, classify = "Sources:Species",
                              vcov = TS.vcov, tdf = den.df)
  validAlldiffs(TS.diffs)
}

## Plot p-values for predictions obtained using asreml or lmerTest
if (exists("TS.diffs"))
{
  plotPvalues(TS.diffs, gridspacing = rep(c(3,4), c(4,2)), show.sig = TRUE)
  plotPvalues(TS.diffs, sections = "Sources", show.sig = TRUE, axis.labels = TRUE)
}
```

---

plotPvalues.data.frame

*Plots a heat map of p-values for pairwise differences between predictions.*

---

## Description

Produces a heat-map plot of the p-values for pairwise differences between predictions that is in a `data.frame`. The `data.frame` includes two factors whose levels specify, for each p-value, which factor levels are being compared.

## Usage

```
## S3 method for class 'data.frame'
plotPvalues(object, p = "p", x, y,
            gridspacing = 0, show.sig = FALSE, triangles = "both",
            title = NULL, axis.labels = NULL,
            colours = RColorBrewer::brewer.pal(3, "Set2"),
            ggplotFuncs = NULL, printPlot = TRUE, ...)
```

## Arguments

| | |
|---|---|
| object | A `data.frame` containing the three columns specified by p, x and y. |
| p | A `character` giving the name of the column in `object` that contains the p-values to be plotted. |
| x | A `character` giving the name of the column in `object` that contains the factor whose levels index the p-values that are to be plotted in the same column. |
| y | A `character` giving the name of the column in `object` that contains the labels of the the p-values that are to be plotted as the rows. |
| gridspacing | A `numeric` specifying the number(s) of rows and columns that form groups in the grid of differences. This is most useful when two or more factors index the rows and columns. If a single, nonzero number, *k* say, is given then a grid line is placed after every *k*th row and column. If a vector of values is given then the number of grid lines is the length of the vector and the spacing between each is specified by the elements of the vector. |
| show.sig | A `logical` that specifies whether asterisks indicating the level of significance are to be added to the plot. If they are then '***' indicates that $p \leq 0.001$, '**' that $0.001 < p \leq 0.01$, '*' that $0.01 < p \leq 0.05$ '.' that $0.05 < p \leq 0.10$. |
| triangles | A `character` indicating whether the plot should include the `lower`, `upper` or `both` traingle(s). Here it is only used to adjust gridlines for the omission of the diagonal. |
| title | A `character` string giving the main title for the plot. |
| axis.labels | A `character` string giving the label to use for both the x- and y-axis. |
| colours | A vector of of colours to be passed to the ggplot function `scale_colour_gradientn`. |
| ggplotFuncs | A [list](#), each element of which contains the results of evaluating a [ggplot](#) function. It is created by calling the [list](#) function with a [ggplot](#) function call for each element. It is passed to ggplot. |
| printPlot | A `logical` indicating whether or not the a plot is to be printed. This would be used when just the returned ggplot object is required. |
| ... | Provision for passsing arguments to functions called internally - not used at present. |

## Value

An object of class "[ggplot](#)", which can be plotted using `print` or otherwise manipulated.

**Author(s)**

Chris Brien

**See Also**

[plotPvalues.alldiffs](#), [allDifferences.data.frame](#), ggplot

**Examples**

```
data(WaterRunoff.dat)

##Use asreml to get predictions and associated statistics

## Not run:
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = pH ~ Benches + (Sources * (Type + Species)),
                      random = ~ Benches:MainPlots,
                      keep.order=TRUE, data= WaterRunoff.dat))
current.asrt <- as.asrtests(current.asr, NULL, NULL)
SS.diffs <- predictPlus.asreml(classify = "Sources:Type",
                               asreml.obj = current.asr, tables = "none",
                               wald.tab = current.asrt$wald.tab,
                               present = c("Type","Species","Sources"))

## End(Not run)

## Use lmeTest and emmmeans to get predictions and associated statistics

if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(pH ~ Benches + (Sources * (Type + Species)) +
                              (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  TS.emm <- emmeans::emmeans(m1.lmer, specs = ~ Sources:Species)
  TS.preds <- summary(TS.emm)
  den.df <- min(TS.preds$df, na.rm = TRUE)
  ## Modify TS.preds to be compatible with a predictions.frame
  TS.preds <- as.predictions.frame(TS.preds, predictions = "emmean",
                                   se = "SE", interval.type = "CI",
                                   interval.names = c("lower.CL", "upper.CL"))

  ## Form an all.diffs object and check its validity
  TS.vcov <- vcov(TS.emm)
  TS.diffs <- allDifferences(predictions = TS.preds, classify = "Sources:Species",
                             vcov = TS.vcov, tdf = den.df)
  validAlldiffs(TS.diffs)
}

## Plot p-values for predictions obtained using asreml or lmerTest
if (exists("TS.diffs"))
{
  p <- within(reshape::melt(TS.diffs$p.differences),
              {
                X1 <- factor(X1, levels=dimnames(TS.diffs$p.differences)[[1]])
                X2 <- factor(X2, levels=levels(X1))
```

```
              })
  names(p)[match("value", names(p))] <- "p"
  plotPvalues(p, x = "X1", y = "X2",
              gridspacing = rep(c(3,4), c(4,2)), show.sig = TRUE)
}
```

---

plotVariofaces.data.frame

*Plots empirical variogram faces, including envelopes, from supplied*
*residuals as described by Stefanova, Smith & Cullis (2009).*

---

### Description

Produces a plot for each face of an empirical 2D `variogram` based on supplied residuals from both an observed data set and simulated data sets. Those from simulated data sets are used to produce confidence envelopes If the data consists of sections, such as separate experiments, the two variogram faces are produced for each section. This function is less efficient in storage terms than `variofaces.asreml`, because here the residuals from all simulated data sets must be saved, in addition to the values for the variogram faces; in `variofaces.asreml`, the residuals for each simulated data set are discarded after the variogram has been calculated. On the other hand, the present function is more flexible, because there is no restriction on how the residuals are obtained.

### Usage

```
## S3 method for class 'data.frame'
plotVariofaces(data, residuals, restype="Residuals", ...)
```

### Arguments

| | |
|---|---|
| data | A `data.frame` with either 3 or 4 columns. Only if there are 4 columns, the first should be a factor indexing sections for which separate variogram plots are to be produced. In either case, the other 3 columns should be, in order, (i) a factor indexing the x-direction, (ii) a factor indexing the y-direction, and (iii) the residuals for the observed response. |
| residuals | A `data.frame`, with either 2 or 3 initial columns followed by columns, each of which are the residuals from a simulated data set. |
| restype | A `character` describing the type of residuals that have been supplied. It will be used in the plot titles. |
| ... | Other arguments that are passed down to the function `asreml.variogram`. |

### Details

For each set of residuals, `asreml.variogram` is used to obtain the empirical variogram, from which the values for its faces are obtained. Plots are produced for each face and include the observed residuals and the 2.5%, 50% & 97.5% quantiles.

**Value**

A `list` with the following components:

1. **face1:** a `data.frame` containing the variogram values on which the plot for the first dimension is based.

2. **face2:** a `data.frame` containing the variogram values on which the plot for the second dimension is based.

**Author(s)**

Chris Brien

**References**

Stefanova, K. T., Smith, A. B. & Cullis, B. R. (2009) Enhanced diagnostics for the spatial analysis of field trials. *Journal of Agricultural, Biological, and Environmental Statistics*, **14**, 392–410.

**See Also**

asremlPlus-package, asreml, asreml.variogram, variofaces.asreml, simulate.asreml.

**Examples**

```
## Not run:
data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary.asrtests(current.asrt)
# Form variance matrix based on estimated variance parameters
s2 <- current.asr$sigma2
gamma.Row <- current.asr$gammas[1]
gamma.unit <- current.asr$gammas[2]
rho.r <- current.asr$gammas[4]
rho.c <- current.asr$gammas[5]
row.ar1 <- mat.ar1(order=10, rho=rho.r)
col.ar1 <- mat.ar1(order=15, rho=rho.c)
V <- gamma.Row * fac.sumop(Wheat.dat$Row) +
  gamma.unit * diag(1, nrow=150, ncol=150) +
  mat.dirprod(col.ar1, row.ar1)
V <- s2*V

#Produce variogram faces plot (Stefanaova et al, 2009)
resid <- simulate(current.asr, V=V, which="residuals")
resid$residuals <- cbind(resid$observed[c("Row","Column")],
                         resid$residuals)
plotVariofaces(data=resid$observed[c("Row","Column","residuals")],
               residuals=resid$residuals,
               restype="Standardized conditional residuals")

## End(Not run)
```

| | |
|---|---|
| powerTransform | *Performs a combination of a linear and a power transformation on a variable. The transformed variable is stored in the* data.frame *data.* |

### Description

Perform a combination of a linear and a power transformation on a variable whose name is given as a character string in var.name. The transformed variable is stored in the data.frame data. The name of the transformed variable is made by prepending to the original var.name a combination of (i) .offset, if offset is nonzero, (ii) neg., if scale is -1, or scaled., if abs(scale) is other than one, and (iii) either log., sqrt., recip. or power., if power is other than one. No action is taken if there is no transformation (i.e. offset = 0, scale = 1 and power = 1). Also, the titles list is extended to include a component with a generated title for the transformed variable with text indicating the transformation prepended to the title for the var.name obtained from the titles list. For nonzero offset, 'Offset ' is prepended, For scaled not equal to one, the possible prepends are 'Negative of ' and 'Scaled '. The possible prepended texts for power not equal to one are 'Logarithm of', 'Square root of ', 'Reciprocal of ' and 'Power nnnn of ', where nnn is the power used.

### Usage

```
powerTransform(var.name, power = 1, offset = 0, scale = 1, titles = NULL, data)
```

### Arguments

| | |
|---|---|
| var.name | A character string specifying the name of the variable in the data.frame data that is to be transformed. |
| power | A number specifying the power to be used in the transformation. If equal to 1, the default, no power transformation is applied. Otherwise, the variable is raised to the specified power, after scaling and applying any nonzero offset. If power = 0, the natural logarithm is used to transform the response; however, if the smallest value to be log-transformed is less than 1e-04, an error is generated. A log-transformation in this situation may be possible if a nonzero offset and/or a scale not equal to one is used. |
| offset | A number to be added to each value of the variable, after any scaling and before applying any power transformation. |
| scale | A number to multiply each value of the variable, before adding any offset and applying any power transformation. |
| titles | A character vector, each element of which is named for a variable in data and is a character string giving a title to use in output (e.g. tables and graphs) involving the variable. If titles are not supplied, the column name of the variable in data is used. |
| data | A data.frame containing the variable to be transformed and to which the transformed variable is to be appended. |

### Value

A list with a component named data that is the data.frame containing the transformed variable, a component named tvar.name that is a character string that is the name of the transformed variable in data, and a component named titles that extends the list supplied in the titles

argument to include a generated title for the transformed title, the name of the new component being tvar.name.

**Author(s)**

Chris Brien

**See Also**

angular, angular.mod.

**Examples**

```
## set up a factor with labels
x.dat <- data.frame(y = c(14, 42, 120, 150))

## transform y to logarithms
trans <- powerTransform("y", power = 0, titles=list(y = "Length (cm)"), data = x.dat)
x.dat <- trans$data
tvar.name <- trans$tvar.name

## transform y to logarithms after multiplying by -1 and adding 1.
z.dat <- data.frame( y = c(-5.25, -4.29, -1.22, 0.05))
trans <- powerTransform("y", power = 0, scale = -1, offset = 1 ,
                        titles=list(y = "Potential"), data = z.dat)
z.dat <- trans$data
tvar.name <- trans$tvar.name
```

---

predictions.frame  *Description of a predictions object*

---

**Description**

A data.frame of S3-class predictions.frame that stores the predictions for a fitted model.

as.predictions.frame is function that converts a data.frame to an object of this class.

is.predictions.frame is the membership function for this class; it tests that an object has class predictions.frame.

validPredictionsFrame can be used to test the validity of a predictions.frame.

**Value**

A data.frame being a data.frame beginning with the variables classifying the predictions, in the same order as in the classify, and also containing columns named standard.error and est.status; each row contains a single predicted value. The usual name of the column containing the predictions is predicted.value or backtransformed.predictions. The number of rows should equal the number of unique combinations of the classifying variables. While such a data.frame can be constructed from the beginning, the pvals component of the value produced by predict.asreml is a suitable value to supply for this argument. Note that the names standard.error and est.status have been changed to std.error and status in the pvals component produced by asreml-R4; if the new names are in the data.frame supplied to predictions, they will be returned to the previous names.

The data.frame may also include columns for the lower and upper values of error intervals, either standard error, confidence or half-LSD intervals. The names of these columns will consist of three parts separated by full stops: 1) the first part will be lower or upper; 2) the second part will be one of Confidence, StandardError or halfLeastSignificant; 3) the third component will be limits.

See predictPlus.asreml for more information.

## Author(s)

Chris Brien

## See Also

predictPlus.asreml, is.predictions.frame, as.predictions.frame, validPredictionsFrame

## Examples

```
data(Oats.dat)

## Use asreml to get predictions and associated statistics

## Not run:
m1.asr <- asreml(Yield ~ Nitrogen*Variety,
                 random=~Blocks/Wplots,
                 data=Oats.dat)
current.asrt <- as.asrtests(m1.asr)
Var.pred <- asreml::predict.asreml(m1.asr, classify="Nitrogen:Variety",
                                   sed=TRUE)
if (getASRemlVersionLoaded(nchar = 1) == "3")
  Var.pred <- Var.pred$predictions
Var.preds <- as.predictions.frame(Var.pred$pvals, se = "std.error",
                                  est.status = "status")

## End(Not run)

## Use lmerTest and emmmeans to get predictions and associated statistics
if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(Yield ~ Nitrogen*Variety + (1|Blocks/Wplots),
                            data=Oats.dat)
  Var.emm <- emmeans::emmeans(m1.lmer, specs = ~ Nitrogen:Variety)
  Var.preds <- summary(Var.emm)
  Var.preds <- as.predictions.frame(Var.preds, predictions = "emmean",
                                    se = "SE", interval.type = "CI",
                                    interval.names = c("lower.CL", "upper.CL"))
}

if (exists("Var.preds"))
{
  ## Check the class and validity of the alldiffs object
  is.predictions.frame(Var.preds)
  validPredictionsFrame(Var.preds)
}
```

| predictPlus.asreml | *Forms the predictions for a term, their pairwise differences and associated statistics. A factor having parallel values may occur in the model and a linear transformation of the predictions can be specified. It results in an object of class alldifffs.* |
|---|---|

### Description

This function forms the predictions for `term` using `classify` and the supplied `asreml` object and stores them in an `alldiffs.object`. If `x.num` is supplied, the predictions will be obtained for the values supplied in `x.pred.values` and, if supplied, `x.plot.values` will replace them in the `alldiffs.object` that is returned. If `x.fac`, but not `x.num`, is specified, predictions will involve it and, if supplied, `x.plot.values` will replace the levels of `x.fac` in the `alldiffs.object` that is returned. In order to get the correct predictions you may need to supply additional arguments to `predict.asreml` through `...` e.g. `present`, `parallel`, `levels`. Any aliased predictions will be removed, as will any standard error of pairwise differences involving them.

Also calculated are the approximate degrees of freedom of the standard errors of the predictions. If the deominator degrees of freedom for `term` are available in `wald.tab`, they are used. Otherwise the residual degrees of freedom or the maximum of the denominator degrees in `wald.tab`, excluding the Intercept, are used. Which is used depends on the setting of `dDF.na`. These degrees of freedom are used for the t-distribution on which p-values and confidence intervals are based. It is stored as an attribute to the `alldiffs.object`. The degrees of freedom are also used in calculating the minimum, mean and maximum LSD for comparing pairs of predictions, which are also stored in the `alldiffs.object`.

If `pairwise = TRUE`, all pairwise differences between the `predictions`, their standard errors, p-values and LSD statistics are computed using `allDifferences.data.frame`. This adds them to the `alldiffs.object` as additional `list` components named `differences`, `sed`, `p.differences` and `LSD`.

If a linear transformation of the predictions is specified then the values of this linear transformation are returned, instead of the original predictions, along with their standard errors and the pairwise differences and associated statistics.

If a transformation has been applied in the analysis (any one of `transform.power` is not one, `scale` is not one and `offset` is nonzero), the backtransforms of the transformed values and their lower and upper error intervals are added to a `data.frame` that is consistent with the `predictions` `data.frame`.

If `transform.power` is other than one, the `standard.error` column of the `data.frame` is set to `NA`. This `data.frame` is added to the `alldiffs.object` as a `list` component called `backtransforms`.

The printing of the components produced is controlled by the `tables` argument. The order of plotting the levels of one of the factors indexing the predictions can be modified and is achieved using `sort.alldiffs`.

### Usage

```
## S3 method for class 'asreml'
predictPlus(asreml.obj, classify, term = NULL,
            linear.transformation = NULL, titles = NULL,
            x.num = NULL, x.fac = NULL,
            x.pred.values = NULL, x.plot.values = NULL,
            error.intervals = "Confidence", avsed.tolerance = 0.25,
```

```
                      meanLSD.type = "overall", LSDby = NULL,
                      pairwise = TRUE, Vmatrix = FALSE,
                      tables = "all" , level.length = NA,
                      transform.power = 1, offset = 0, scale = 1,
                      inestimable.rm = TRUE,
                      sortFactor = NULL, sortWithinVals = NULL,
                      sortOrder = NULL, decreasing = FALSE,
                      wald.tab = NULL, alpha = 0.05,
                      dDF.na = "residual",  dDF.values = NULL,
                      trace = FALSE, ...)
```

## Arguments

| | |
|---|---|
| asreml.obj | asreml object for a fitted model. |
| classify | A [character](#) string giving the variables that define the margins of the multi-way table to be predicted. Multiway tables are specified by forming an interaction type term from the classifying variables, that is, separating the variable names with the : operator. To predict the overall mean, set the classify to "(Intercept)". |
| term | A [character](#) string giving the variables that define the term that was fitted using asreml and that corresponds to classify. It only needs to be specified when it is different to classify. |
| linear.transformation | |

        A [formula](#) or a [matrix](#). If a [formula](#) is given then it is taken to be a submodel of the model term corresponding to the classify. The projection matrix that transforms the predictions so that they conform to the submodel is obtained; the submodel should involving the variables in the classify. For example, for classify set to "A:B", the submodel ~ A + B will result in the predictions for the combinations of A and B being made additive for the [factor](#)s A and B.

        If a [matrix](#) is provided then it will be used to apply the linear transformation to the predictions. It might be a contrast [matrix](#) or a [matrix](#) of weights for a factor used to obtain the weighted average over that factor. The number of rows in the [matrix](#) should equal the number of linear combinations of the predictions desired and the number of columns should equal the number of predictions.

        In either case, as well as the values of the linear combinations, their standard errors, pairwise differences and associated statistics are returned.

| | |
|---|---|
| titles | A [list](#), each component of which is named for a column in the data.frame for asreml.obj and contains a character string giving a title to use in output (e.g. tables and graphs). Here they will be used for table headings. |
| x.num | A [character](#) string giving the name of the numeric covariate that (i) corresponds to x.fac, (ii) is potentially included in terms in the fitted model, and (iii) which corresponds to the x-axis variable. It should have the same number of unique values as the number of levels in x.fac. |
| x.fac | A [character](#) string giving the name of the factor that (i) corresponds to x.num, (ii) is potentially included in terms in the fitted model, and (iii) which corresponds to the x-axis variable. It should have the same number of levels as the number of unique values in x.num. The levels of x.fac must be in the order in which they are to be plotted - if they are dates, then they should be in the form yyyymmdd, which can be achieved using as.Date. However, the levels can be non-numeric in nature, provided that x.num is also set. |

x.pred.values       The values of x.num for which predicted values are required. If levels is set
                    for passing to predict.asreml, x.pred.values is ignored. Note that while
                    levels is and alternative to x.pred.values, it allows more general setting of
                    the levels to be predicted.

x.plot.values       The actual values to be plotted on the x axis. They are needed when values
                    different to those in x.num are to be plotted or x.fac is to be plotted because
                    there is no x.num term corresponding to the same term with x.fac.

error.intervals

                    A [character](#) string indicating the type of error interval, if any, to calculate
                    in order to indicate uncertainty in the results. Possible values are "none",
                    "StandardError", "Confidence" and "halfLeastSignificant". The de-
                    fault is for confidence limits to be used. The "halfLeastSignificant" option
                    results in half the Least Significant Difference (LSD) being added and subtracted
                    to the predictions, the LSD being calculated using the square root of the mean of
                    the variances of all or a subset of pairwise differences between the predictions. If
                    meanLSD.type is set to overall, the avsed.tolerance is not NA and the range
                    of the SEDs divided by the average of the SEDs exceeds avsed.tolerance then
                    the error.intervals calculations and the plotting will revert to confidence in-
                    tervals.

avsed.tolerance

                    A [numeric](#) giving the value of the SED range, the range of the SEDs divided
                    by the square root of the mean of the variances of all or a subset of the pairwise
                    differences, that is considered reasonable in calculating error.intervals. It
                    should be a value between 0 and 1. The following rules apply:

                    1. If avsed.tolerance is NA then mean LSDs of the type specified by meanLSD.type
                       are calculated and used in error.intervals and plots.
                    2. Irrespective of the setting of meanLSD.type, if avsed.tolerance is not
                       exceeded then the mean LSDs are used in error.intervals and plots.
                    3. If meanLSD.type is set to overall, avsed.tolerance is not NA, and avsed.tolerance
                       is exceeded then error.intervals and plotting revert to confidence inter-
                       vals.
                    4. If meanLSD.type is set to factor.combinations and avsed.tolerance
                       is not exceeded for any factor combination then the half LSDs are used
                       in error.intervals and plots; otherwise, error.intervals and plotting
                       revert to confidence intervals.
                    5. If meanLSD.type is set to per.prediction and avsed.tolerance is not
                       exceeded for any prediction then the half LSDs are used in error.intervals
                       and plots; otherwise, error.intervals and plotting revert to confidence
                       intervals.

meanLSD.type        A [character](#) string determining whether the mean LSD stored is (i) the overall
                    mean, based on the square root of the mean of the variances of all pairwise vari-
                    ances, (ii) the mean for each factor.combination of the [factor](#)s specified by
                    LSDby, which is based on the square root of the mean of the variances for all pair-
                    wise differences for each factor combination, unless there is only one predction
                    for a factor.combination, when notional LSDs are calculated that are based
                    on the standard error of the prediction multiplied by the square root of two, or
                    (iii) the per.prediction mean, based, for each prediction, on the square root of
                    the mean of the variances for all pairwise differences involving that prediction.
                    It also determines, in conjunction with avsed.tolerance, which LSD will be
                    used in calculating error.intervals and, hence, is used for plots.

| | |
|---|---|
| LSDby | A [character](vector) of variables names, being the names of the [factor](s) or [numeric](s) in the classify for each combination of which a mean LSD, minLSD and max LSD is stored in the LSD component of the [alldiffs.object](when meanLSD.type is factor.combinatons. |
| pairwise | A [logical] indicating whether all pairwise differences of the predictions and their standard errors and p-values are to be computed and stored. If tables is equal to "differences" or "all" or error.intervals is equal to "halfLeastSignificant", they will be stored irrespective of the value of pairwise. |
| Vmatrix | A [logical] indicating whether the variance matrix of the predictions will be stored as a component of the [alldiffs.object] that is returned. If linear.transformation is set, it will be stored irrespective of the value of Vmatrix. |
| tables | A [character] vector containing a combination of none, predictions, vcov, backtransforms, differences, p.differences, sed, LSD and all. These nominate which components of the [alldiffs.object] to print. |
| level.length | The maximum number of characters from the the levels of factors to use in the row and column labels of the tables of pairwise differences and their p-values and standard errors. |
| transform.power | |
| | A [numeric] specifying the power of a transformation, if one has been applied to the response variable. Unless it is equal to 1, the default, back-transforms of the predictions will be obtained and presented in tables or graphs as appropriate. The back-transformation raises the predictions to the power equal to the reciprocal of transform.power, unless it equals 0 in which case the exponential of the predictions is taken. |
| offset | A [numeric] that has been added to each value of the response after any scaling and before applying any power transformation. |
| scale | A [numeric] by which each value of the response has been multiplied before adding any offset and applying any power transformation. |
| inestimable.rm | A logical indicating whether rows for predictions that are not estimable are to be removed from the components of the [alldiffs.object]. |
| sortFactor | A character containing the name of the factor that indexes the set of predicted values that determines the sorting of the components of the [alldiffs.object] by [sort.alldiffs]. If NULL then sorting is not carried out. If there is more than one variable in the classify term then sortFactor is sorted for the predicted values within each combination of the values of the sortWithin variables: the classify variables, excluding the sortFactor. There should be only one predicted value for each unique value of sortFactor within each set defined by a combination of the values of the sortWithin variables. |
| sortWithinVals | A list with a component named for each factor and numeric that is a classify variable for the predictions, excluding sortFactor. Each component should contain a single value that is a value of the variable. The combination of this set of values will be used to define a subset of the predicted values whose order will define the order of sortFactor to be used for all combinations of the sortWithinVals variables. If sortWithinVals is NULL then the first value of each sortWithin variable in predictions component is used to define sortWithinVals. If there is only one variable in the classify then sortWithinVals is ignored. |
| sortOrder | A character vector whose length is the same as the number of levels for sortFactor in the predictions component of the [alldiffs.object]. It specifies the desired order of the levels in the reordered components of the [alldiffs.object]. The argument sortWithinVals is ignored. |

The following creates a sortOrder vector levs for factor f based on the values in x: levs <-levels(f)[order(x)].

decreasing          A logical passed to order that detemines whether the order for sorting the components of the [alldiffs.object](#) is for increasing or decreasing magnitude of the predicted values.

wald.tab            A [data.frame](#) containing the pseudo-anova table for the fixed terms produced by a call to wald.asreml. The main use of it here is in determinining the degrees of freedom of the standard errors of the predictions. denominator degrees of freedom when p-values or confidence intervals are to be calculated.

alpha               A [numeric](#) giving the significance level for LSDs or one minus the confidence level for confidence intervals.

dDF.na              A [character](#) specifying the method to use to obtain approximate denominator degrees of freedom. when the numeric or algebraic methods produce an NA. Consistent with when no denDF are available, the default is "residual" and so the residual degrees of freedom from asreml.obj$nedf are used. If dDF.na = "none", no subtitute denominator degrees of freedom are employed; if dDF.na = "maximum", the maximum of those denDF that are available, excluding that for the Intercept, is used; if all denDF are NA, asreml.obj$nedf is used. If dDF.na = "supplied", a vector of values for the denominator degrees of freedom is to be supplied in dDF.values. Any other setting is ignored and a warning message produced. Generally, substituting these degrees of freedom is anticonservative in that it is likely that the degrees of freedom used will be too large.

dDF.values          A [vector](#) of values to be used when dDF.na = "supplied". Its values will be used when denDF in a test for a fixed effect is NA. This vector must be the same length as the number of fixed terms, including (Intercept) whose value could be NA.

trace               A [logical](#) that control output from ASReml-R. If TRUE then partial iteration details are displayed when ASReml-R functions are invoked; if FALSE then no output is displayed.

...                 further arguments passed to predict.asreml.

## Value

For linear.transformations set to NULL, an S3-class [alldiffs.object](#) with predictions and their standard errors and, depending on the settings of the arguments, all pairwise differences between predictions, their standard errors and p-values and LSD statistics. Also, unless the sortFactor or sortOrder arguments are invoked, the rows of predictions component are ordered so that they are in standard order for the variables in the classify. That is, the values of the last variable change with every row, those of the second-last variable only change after all the values of the last variable have been traversed; in general, the values of a variable are the same for all the combinations of the values to the variables to its right in the classify. In addition, if necessary, the order of the columns of the variables in the predictions component are changed to match their order in the classify.

If transform.power or scale is not one or offset is not zero, it will contain a data.frame with the backtransformed linear transformation of the predictions. The backtransformation will, after backtransforming for any power transformation, subtract the offset and then divide by the scale.

If error.intervals is not "none", then the predictions component and, if present, the backtransforms component will contain columns for the lower and upper values of the limits for the interval.

The name of the response, the response.title, the term, the classify, tdf, sortFactor and the sortOrder will be set as attributes to the object. Note that the classify in an [alldiffs.object](#)

is based on the variables indexing the predictions, which may differ from the classify used to obtain the original predictions (for example, when the [alldiffs.object](#)s stores a linear transformation of predictions.

For linear.transformations set to other than NULL, an [alldiffs.object](#) with the linear.transformation applied to the predictions and their standard errors and, depending on the settings of the arguments, all pairwise differences between the linearly transformed predictions, their standard errors and p-values and LSD statistics. (See also [linTransform.alldiffs](#).)

### Author(s)

Chris Brien

### See Also

[alldiffs.object](#), [as.alldiffs](#), [print.alldiffs](#), [linTransform.alldiffs](#), [sort.alldiffs](#), [subset.alldiffs](#), [allDifferences.data.frame](#), [redoErrorIntervals.alldiffs](#), [recalcLSD.alldiffs](#), [predictPresent.asreml](#), [plotPredictions.data.frame](#), as.Date, predict.asreml

### Examples

```
## Not run:
data(WaterRunoff.dat)
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = pH ~ Benches + (Sources * (Type + Species)),
                      random = ~ Benches:MainPlots,
                      keep.order=TRUE, data= WaterRunoff.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
diffs <- predictPlus(classify = "Sources:Type",
                     asreml.obj = current.asr,
                     wald.tab = current.asrt$wald.tab,
                     present = c("Sources", "Type", "Species"))

## End(Not run)
```

---

predictPresent.asreml   *Forms the predictions for each of one or more terms and presents them in tables and/or graphs.*

---

### Description

This function forms the predictions for each term in terms using a supplied asreml object and [predictPlus.asreml](#). Tables are produced using [predictPlus.asreml](#), in conjunction with [allDifferences.data.frame](#), with the argument tables specifying which tables are printed. The argument plots, along with transform.power, controls which plots are produced. The plots are produced using [plotPredictions.data.frame](#), with line plots produced when variables involving x.num or x.fac are involved in classify for the predictions and bar charts otherwise. In order to get the correct predictions you may need to supply additional arguments to predict.asreml through ... e.g. present, parallel, levels.

The order of plotting the levels of one of the factors indexing the predictions can be modified and is achieved using [sort.alldiffs](#).

**Usage**

```
## S3 method for class 'asreml'
predictPresent(asreml.obj, terms,
                linear.transformation = NULL,
                wald.tab = NULL, dDF.na = "residual", dDF.values = NULL,
                x.num = NULL, x.fac = NULL, nonx.fac.order = NULL,
                x.pred.values = NULL, x.plot.values = NULL,
                plots = "predictions", panels = "multiple",
                graphics.device = NULL,
                error.intervals = "Confidence", meanLSD.type = "overall",
                LSDby = NULL, avsed.tolerance = 0.25, titles = NULL,
                colour.scheme = "colour", save.plots = FALSE,
                transform.power = 1, offset = 0, scale = 1,
                pairwise = TRUE, Vmatrix = FALSE,
                tables = "all", level.length = NA,
                alpha = 0.05, inestimable.rm = TRUE,
                sortFactor = NULL, sortWithinVals = NULL,
                sortOrder = NULL, decreasing = FALSE,
                trace = FALSE, ggplotFuncs = NULL, ...)
```

**Arguments**

asreml.obj        asreml object for a fitted model.

terms             A character vector giving the terms for which predictions are required.

linear.transformation

> A [formula](#) or a [matrix](#) specifying a linear transformation to be applied to the
> predictions. If a [formula](#) is given then it is taken to be a submodel of the model
> term corresponding to the classify. The projection matrix that transforms the
> predictions so that they conform to the submodel is obtained; the submodel
> should involving the variables in the classify. For example, for classify set
> to "A:B", the submodel ~ A + B will result in the predictions for the combina-
> tions of A and B being made additive for the [factor](#)s A and B.

> If a [matrix](#) is provided then it will be used to apply the linear transformation
> to the predictions. It might be a contrast [matrix](#) or a [matrix](#) of weights
> for a factor used to obtain the weighted average over that factor. The number
> of rows in the [matrix](#) should equal the number of linear combinations of the
> predictions desired and the number of columns should equal the number of
> predictions.

> In either case, as well as the values of the linear combinations, their standard er-
> rors, pairwise differences and associated statistics are returned in the [alldiffs.object](#).

wald.tab          A data frame containing the pseudo-anova table for the fixed terms produced
                  by a call to wald.asreml. The main use of it here is in getting denominator
                  degrees of freedom when confidence intervals are to be plotted.

dDF.na            The method to use to obtain approximate denominator degrees of freedom.
                  when the numeric or algebraic methods produce an NA. Consistent with when
                  no denDF are available, the default is "residual" and so the residual degrees
                  of freedom from asreml.obj$nedf are used. If dDF.na = "none", no substi-
                  tute denominator degrees of freedom are employed; if dDF.na = "maximum", the
                  maximum of those denDF that are available, excluding that for the Intercept, is
                  used; if all denDF are NA, asreml.obj$nedf is used. If dDF.na = "supplied",
                  a vector of values for the denominator degrees of freedom is to be supplied

in dDF.values. Any other setting is ignored and a warning message produced. Generally, substituting these degrees of freedom is anticonservative in that it is likely that the degrees of freedom used will be too large.

dDF.values     A vector of values to be used when dDF.na = "supplied". Its values will be used when denDF in a test for a fixed effect is NA. This vector must be the same length as the number of fixed terms, including (Intercept) whose value could be NA.

x.num          A character string giving the name of the numeric covariate that corresponds to x.fac, is potentially included in terms in the fitted model and which corresponds to the x-axis variable. It should have the same number of unique values as the number of levels in x.fac.

x.fac          A character string giving the name of the factor that corresponds to x.num, is potentially included in terms in the fitted model and which corresponds to the x-axis variable. It should have the same number of levels as the number of unique values in x.num. The levels of x.fac must be in the order in which they are to be plotted - if they are dates, then they should be in the form yyyymmdd, which can be achieved using as.Date. However, the levels can be non-numeric in nature, provided that x.num is also set.

nonx.fac.order A character vector giving the order in which factors other than x.fac are to be plotted in plots with multiple panels (i.e. where the number of non-x factors is greater than 1). The first factor in the vector will be plotted on the X axis (if there is no x.num or x.fac. Otherwise, the order of plotting the factors is in columns (X facets) and then rows (Y facets). By default the order is in decreasing order for the numbers of levels of the non x factors.

x.pred.values  The values of x.num for which predicted values are required.

x.plot.values  The actual values to be plotted on the x axis or in the labels of tables. They are needed when values different to those in x.num are to be plotted or x.fac is to be plotted because there is no x.num term corresponding to the same term with x.fac.

plots          Possible values are "none", "predictions", "backtransforms" and "both". Plots are not produced if the value is "none". If data are not transformed for analysis (transform.power = 1), a plot of the predictions is produced provided plots is not "none". If the data are transformed, the value of plots determines what is produced.

panels         Possible values are "single" and "multiple". When line plots are to be produced, because variables involving x.num or x.fac are involved in classify for the predictions, panels determines whether or not a single panel or multiple panels in a single window are produced. The panels argument is ignored for for bar charts.

graphics.device
               A character specifying a graphics device for plotting. The default is graphics.device = NULL, which will result in plots being produced on the current graphics device. Setting it to "windows", for example, will result in a windows graphics device being opened.

error.intervals
               A character string indicating the type of error interval, if any, to calculate in order to indicate uncertainty in the results. Possible values are "none", "StandardError", "Confidence" and "halfLeastSignificant". The default is for confidence limits to be used. The "halfLeastSignificant" option results in half the Least Significant Difference (LSD) being added and subtracted

to the predictions, the LSD being calculated using the square root of the mean of the variances of all or a subset of pairwise differences between the predictions. If meanLSD.type is set to overall, the avsed.tolerance is not NA and the range of the SEDs divided by the average of the SEDs exceeds avsed.tolerance then the error.intervals calculations and the plotting will revert to confidence intervals.

avsed.tolerance

A [numeric](#) giving the value of the SED range, the range of the SEDs divided by the square root of the mean of the variances of all or a subset of the pairwise differences, that is considered reasonable in calculating error.intervals. It should be a value between 0 and 1. The following rules apply:

1. If avsed.tolerance is NA then mean LSDs of the type specified by meanLSD.type are calculated and used in error.intervals and plots.
2. Irrespective of the setting of meanLSD.type, if avsed.tolerance is not exceeded then the mean LSDs are used in error.intervals and plots.
3. If meanLSD.type is set to overall, avsed.tolerance is not NA, and avsed.tolerance is exceeded then error.intervals and plotting revert to confidence intervals.
4. If meanLSD.type is set to factor.combinations and avsed.tolerance is not exceeded for any factor combination then the half LSDs are used in error.intervals and plots; otherwise, error.intervals and plotting revert to confidence intervals.
5. If meanLSD.type is set to per.prediction and avsed.tolerance is not exceeded for any prediction then the half LSDs are used in error.intervals and plots; otherwise, error.intervals and plotting revert to confidence intervals.

meanLSD.type    A [character](#) string determining whether the mean LSD stored is (i) the overall mean, based on the square root of the mean of the variances of all pairwise variances, (ii) the mean for each factor.combination of the [factor](#)s specified by LSDby, which is based on the square root of the mean of the variances for all pairwise differences for each factor combination, unless there is only one predction for a factor.combination, when notional LSDs are calculated that are based on the standard error of the prediction multiplied by the square root of two, or (iii) the per.prediction mean, based, for each prediction, on the square root of the mean of the variances for all pairwise differences involving that prediction. It also determines, in conjunction with avsed.tolerance, which LSD will be used in calculating error.intervals and, hence, is used for plots.

LSDby           A [character](#) (vector) of variables names, being the names of the [factor](#)s or [numeric](#)s in the classify for each combination of which a mean LSD, minLSD and max LSD is stored in the LSD component of the [alldiffs.object](#) when meanLSD.type is factor.combinatons.

titles          A list, each component of which is named for a column in the data.frame for asreml.obj and contains a character string giving a title to use in output (e.g. tables and graphs). Here they will be used for axis labels.

colour.scheme   A character string specifying the colour scheme for the plots. The default is "colour" which produces coloured lines and bars, a grey background and white gridlines. A value of "black" results in black lines, grey bars and gridlines and a white background.

save.plots      A logical that determines whether any plots will be saved. If they are to be saved, a file name will be generated that consists of the following elements separated by full stops: the response variable name with .back if backtransformed

values are being plotted, the classify term, Bar or Line and, if error.intervals is not "none", one of SE, CI or LSI. The file will be saved as a 'png' file in the current work directory.

transform.power

A number specifying the power of a transformation, if one has been applied to the response variable. Unless it is equal to 1, the default, back-transforms of the predictions will be obtained and presented in tables or graphs as appropriate. The back-transform will raise the predictions to the power equal to the reciprocal of transform.power, unless it equals 0 in which case the exponential will be taken. Any scaling and offsetting will also be taken into account in the backtransformation.

offset
A number that has been added to each value of the response after any scaling and before applying any power transformation. Unless it is equal to 0, the default, back-transforms of the predictions will be obtained and presented in tables or graphs as appropriate. The backtransformation will, after backtransforming for any power transformation, subtract the offset.

scale
A number by which each value of the response has been multiply before adding any offset and applying any power transformation. Unless it is equal to 1, the default, back-transforms of the predictions will be obtained and presented in tables or graphs as appropriate. The backtransformation will, after backtransforming for any power transformation and then subtracting the offset, divide by the scale.

pairwise
A logical indicating whether all pairise differences of the predictions and their standard errors and p-values are to be computed and stored. If tables is equal to "differences" or "all" or error.intervals is equal to "halfLeastSignificant", they will be stored irrespective of the value of pairwise.

Vmatrix
A logical indicating whether the variance matrix of the predictions will be stored as a component of the alldiffs.object that is returned. If linear.transformation is set, it will be stored irrespective of the value of Vmatrix.

tables
A character vector containing a combination of predictions, vcov, backtransforms, differences, p.differences, sed, LSD and all. These nominate which components of the alldiffs.object to print.

level.length
The maximum number of characters from the the levels of factors to use in the row and column labels of the tables produced by allDifferences.data.frame.

alpha
The significance level for LSDs or 1 - alpha is the confidence level for confidence intervals.

inestimable.rm  A logical indicating whether rows for predictions that are not estimable are to be removed from the components of the alldiffs.object.

sortFactor
A character containing the name of the factor that indexes the set of predicted values that determines the sorting of the components of the alldiffs.object by sort.alldiffs. If NULL then sorting is not carried out. If there is more than one variable in the classify term then sortFactor is sorted for the predicted values within each combination of the values of the sortWithin variables: the classify variables, excluding the sortFactor. There should be only one predicted value for each unique value of sortFactor within each set defined by a combination of the values of the sortWithin variables.

sortWithinVals  A list with a component named for each factor and numeric that is a classify variable for the predictions, excluding sortFactor. Each component should contain a single value that is a value of the variable. The combination of this

set of values will be used to define a subset of the predicted values whose or-
der will define the order of sortFactor to be used for all combinations of the
sortWithinVals variables. If sortWithinVals is NULL then the first value of
each sortWithin variable in predictions component is used to define sortWithinVals.
If there is only one variable in the classify then sortWithinVals is ignored.

sortOrder        A character vector whose length is the same as the number of levels for
                 sortFactor in the predictions component of the alldiffs.object. It speci-
                 fies the desired order of the levels in the reordered components of the alldiffs.object.
                 The argument sortWithinVals is ignored.

                 The following creates a sortOrder vector levs for factor f based on the values
                 in x: levs <-levels(f)[order(x)].

decreasing       A logical passed to order that detemines whether the order for sorting the
                 components of the alldiffs.object is for increasing or decreasing magnitude
                 of the predicted values.

trace            If TRUE then partial iteration details are displayed when ASReml-R functions
                 are invoked; if FALSE then no output is displayed.

ggplotFuncs      A list, each element of which contains the results of evaluating a ggplot func-
                 tion. It is created by calling the list function with a ggplot function call for
                 each element. It is passed to plotPredictions.data.frame.

...              further arguments passed to predict.asreml via predictPlus.asreml and to
                 ggplot via plotPredictions.data.frame.

## Value

A list containing an alldiffs.object for each term for which tables are produced. The names
of the components of this list are the terms with full-stops (.) replacing colons (:). Plots are also
produced depending on the setting of the plot argument.

## Author(s)

Chris Brien

## See Also

predictPlus.asreml, allDifferences.data.frame, sort.alldiffs, subset.alldiffs,
redoErrorIntervals.alldiffs, recalcLSD.alldiffs, plotPredictions.data.frame,
print.alldiffs, as.Date, Devices

## Examples

```
## Not run:
data(WaterRunoff.dat)
titles <- list("Days since first observation", "Days since first observation",
               "pH", "Turbidity (NTU)")
names(titles) <- names(WaterRunoff.dat)[c(5,7,11:12)]
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = log.Turbidity ~ Benches + Sources + Type + Species +
                                  Sources:Type + Sources:Species + Sources:Species:xDay +
                                  Sources:Species:Date,
                      data = WaterRunoff.dat, keep.order = TRUE)
current.asrt <- as.asrtests(current.asr, NULL, NULL)

#### Get the observed combinations of the factors and variables in classify
```

```
      class.facs <- c("Sources","Species","Date","xDay")
      levs <- as.data.frame(table(WaterRunoff.dat[class.facs]))
      levs <- levs[do.call(order, levs), ]
      levs <- as.list(levs[levs$Freq != 0, class.facs])
      levs$xDay <- as.numfac(levs$xDay)

      #### parallel and levels are arguments from predict.asreml
      diff.list <- predictPresent.asreml(asreml.obj = current.asrt$asreml.obj,
                                         terms = "Date:Sources:Species:xDay",
                                         x.num = "xDay", x.fac = "Date",
                                         parallel = TRUE, levels = levs,
                                         wald.tab = current.asrt$wald.tab,
                                         plots = "predictions",
                                         error.intervals = "StandardError",
                                         titles = titles,
                                         transform.power = 0,
                                         present = c("Type","Species","Sources"),
                                         tables = "none",
                                         level.length = 6)

   ## End(Not run)
```

---

print.alldiffs               *Prints the values in an* alldiffs.object *in a nice format.*

---

### Description

Prints the predictions and standard errors from a fitted model, including the attributes of the predictions.frame. Also prints out all pairwise differences between the predictions to 2 signigicant figures, along with their p-values and standard errors to 4 decimal places. If LSDs are requested the mean, minimum and maximum LSDs will be printed.

### Usage

```
## S3 method for class 'alldiffs'
print(x, which = "all", colourise = FALSE, ...)
```

### Arguments

| | |
|---|---|
| x | An alldiffs.object. |
| which | A character vector containing a combination of predictions, vcov, backtransforms, differences, p.differences, sed, LSD and all. These nominate which components of the alldiffs.object to print. |
| colourise | A logical which, if TRUE, results in the header text produced by predict.asreml being displayed in a different colour, if supported by the output terminal device. It overrides the TRUE setting of the colourise argument of asreml::asreml.options. |
| ... | further arguments passed to print.predictions.frame. |

### Value

No value is returned, but the components of x are printed.

## Author(s)

Chris Brien

## See Also

[print.predictions.frame](), [as.alldiffs](), [allDifferences.data.frame]()

## Examples

```
## Not run:
print.alldiffs(diffs, which = "predictions")

## End(Not run)
```

---

print.asrtests            *Prints the values in an* asrtests.object

---

## Description

Prints a summary of the asreml object, the pseusdanova and the test.summary data.frame that are
stored in the asrtests.object.

## Usage

```
## S3 method for class 'asrtests'
print(x, which = "all", colourise = FALSE, ...)
```

## Arguments

| x | An asrtests.object. |
|---|---|
| which | Which elements of the asrtests.object to print. Possible values are some combination of asremlsummary, pseudoanova, wald.tab, testsummary and all. The option wald.tab is a synonym for pseudoanova. |
| colourise | A logical which, if TRUE, results in the header text produced by wald.asreml being displayed in a different colour, if supported by the output terminal device. It overrides the TRUE setting of the colourise argument of asreml::asreml.options. |
| ... | further arguments passed to print and print.wald.tab. |

## Value

No value is returned, but the elements of the list in x are printed.

## Author(s)

Chris Brien

## See Also

[print.wald.tab](), [as.asrtests](), [asremlPlus-package]()

## Examples

```
## Not run:
data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary.asrtests(current.asrt)
# Test Row autocorrelation
current.asrt <- testresidual(current.asrt, , "~ Row:ar1(Column)",
                             label="Row autocorrelation", simpler=TRUE)
print(current.asrt)

## End(Not run)
```

---

print.predictions.frame

> *Prints the values in a* `predictions.frame`*, with or without title and heading.*

---

## Description

Prints the predictions from a fitted model, along with their standard errors and, if present, their error intervals, with or without title and headings.

## Usage

```
## S3 method for class 'predictions.frame'
print(x, title = NULL,
      which.predictions = c("title", "heading", "table"),
      colourise = FALSE, ...)
```

## Arguments

| | |
|---|---|
| x | An object that, ideally, is of class `predictions.frame`. |
| title | A `character` giving a title to be printed out before the heading and table for the `predictions.frame`, |
| which.predictions | what Which elements of the `predictions.frame` to print. Possible values are some combination of `title`, `heading`, `table` and `all`. The heading is an attribute of x. |
| colourise | A `logical` which, if TRUE, results in the header text produced by `predict.asreml` being displayed in a different colour, if supported by the output terminal device. It overrides the TRUE setting of the `colourise` argument of `asreml::asreml.options`, but is only operational when the `table` is also printed. |
| ... | further arguments passed to `print.predictions.frame`. |

## Value

No value is returned, but the components of x are printed.

**Author(s)**

Chris Brien

**See Also**

[print.alldiffs](), [as.alldiffs](), [allDifferences.data.frame]()

**Examples**

```
## Not run:
print.predictions.frame(diffs$predictions, which = "all")

## End(Not run)
```

---

print.wald.tab            *Prints a Wald or pseudoanova table.*

---

**Description**

Prints a wald.tab with or without title and/or heading.

**Usage**

```
## S3 method for class 'wald.tab'
print(x, which.wald = c("title", "heading", "table"),
      colourise = FALSE, ...)
```

**Arguments**

x              A object that, ideally, is of class wald.tab.

which.wald     Which elements of the wald.tab to print. Possible values are some combination
               of title, heading, table and all. The heading is an attribute of x.

colourise      A [logical]() which, if TRUE, results in the header text produced by wald.asreml
               being displayed in a different colour, if supported by the output terminal device.
               It overrides the TRUE setting of the colourise argument of asreml::asreml.options.

...            further arguments passed to print and print.wald.tab, but is only operational
               when the table is also printed.

**Value**

No value is returned, but the elements of the list in x are printed.

**Author(s)**

Chris Brien

**See Also**

[print.asrtests](), [as.asrtests](), [asremlPlus-package]()

## Examples

```
## Not run:
data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary.asrtests(current.asrt)
# Test Row autocorrelation
current.asrt <- testresidual(current.asrt, , "~ Row:ar1(Column)",
                             label="Row autocorrelation", simpler=TRUE)
print(current.asrt$wald.tab)

## End(Not run)
```

---

recalcLSD.alldiffs     *Adds or recalculates the LSD component of an* alldiffs.object.

---

## Description

Given an alldiffs.object, adds or recalculate its LSD component.

## Usage

```
## S3 method for class 'alldiffs'
recalcLSD(alldiffs.obj, meanLSD.type = "overall", LSDby = NULL,
          alpha = 0.05, ...)
```

## Arguments

alldiffs.obj    An alldiffs.object.

meanLSD.type    A character string determining whether the mean LSD stored is (i) the overall mean, based on the square root of the mean of the variances of all pairwise variances, (ii) the mean for each factor.combination of the factors specified by LSDby, which is based on the square root of the mean of the variances for all pairwise differences for each factor combination, unless there is only one predction for a factor.combination, when notional LSDs are calculated that are based on the standard error of the prediction multiplied by the square root of two, or (iii) the per.prediction mean, based, for each prediction, on the square root of the mean of the variances for all pairwise differences involving that prediction. It also determines, in conjunction with avsed.tolerance, which LSD will be used in calculating error.intervals and, hence, is used for plots.

LSDby           A character (vector) of variables names, being the names of the factors or numerics in the classify for each combination of which a mean LSD, minLSD and max LSD is stored in the LSD component of the alldiffs.object when meanLSD.type is factor.combinatons.

alpha           The significance level for an LSD to compare a pair of predictions.

...             further arguments passed to allDifferences.data.frame.

**Value**

An [alldiffs.object](#) with components predictions, vcov, differences, p.differences sed,
LSD and, if present in alldiffs.obj, backtransforms.

**Author(s)**

Chris Brien

**See Also**

[asremlPlus-package](#), [as.alldiffs](#), [sort.alldiffs](#), [subset.alldiffs](#), [print.alldiffs](#),
[renewClassify.alldiffs](#), [redoErrorIntervals.alldiffs](#), [plotPredictions.data.frame](#),
[predictPlus.asreml](#), [predictPresent.asreml](#)

**Examples**

```
data(WaterRunoff.dat)

##Use asreml to get predictions and associated statistics

## Not run:
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = pH ~ Benches + (Sources * (Type + Species)),
                      random = ~ Benches:MainPlots,
                      keep.order=TRUE, data= WaterRunoff.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
TS.diffs <- predictPlus(classify = "Sources:Type",
                        asreml.obj = current.asr,
                        wald.tab = current.asrt$wald.tab,
                      present = c("Sources", "Type", "Species"))

## End(Not run)

## Use lmeTest and emmmeans to get predictions and associated statistics

if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(pH ~ Benches + (Sources * (Type + Species)) +
                              (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  TS.emm <- emmeans::emmeans(m1.lmer, specs = ~ Sources:Species)
  TS.preds <- summary(TS.emm)
  den.df <- min(TS.preds$df, na.rm = TRUE)
  ## Modify TS.preds to be compatible with a predictions.frame
  TS.preds <- as.predictions.frame(TS.preds, predictions = "emmean",
                                   se = "SE", interval.type = "CI",
                                   interval.names = c("lower.CL", "upper.CL"))

  ## Form an all.diffs object and check its validity
  TS.vcov <- vcov(TS.emm)
  TS.diffs <- allDifferences(predictions = TS.preds, classify = "Sources:Species",
                             vcov = TS.vcov, tdf = den.df)
  validAlldiffs(TS.diffs)
}
```

```
## Plot p-values for predictions obtained using asreml or lmerTest
if (exists("TS.diffs"))
{
  ##Recalculate the LSD values for predictions obtained using asreml or lmerTest
  TS.diffs <- recalcLSD.alldiffs(TS.diffs, meanLSD.type = "factor.combinations",
                                 LSDby = "Sources")
}
```

---

recalcWaldTab.asrtests

*Recalculates the denDF, F.inc and P values for a table of Wald test statistics obtained using* wald.asreml

---

## Description

If some or all denDF are not available, either because they are NA or because F.inc values were not calculated, this function allows the user to specify how approximate denDF values are to be obtained. This is done through the dDF.na and dDF.values arguments. Note that if denDF values are available in the Wald table then only those that are NA will be replaced. The P values are recalculated using F.con, if present in the wald.tab, otherwise F.inc is used. It is noted that, as of asreml version 4, wald.asreml has a kenadj argument.

## Usage

```
## S3 method for class 'asrtests'
recalcWaldTab(asrtests.obj, recalc.wald = FALSE,
              denDF="numeric", dDF.na = "none",
              dDF.values = NULL, trace = FALSE, ...)
```

## Arguments

| | |
|---|---|
| asrtests.obj | an asrtests.object containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary. |
| recalc.wald | A logical indicating whether to call wald.asreml to recalculate the pseudoanova table for the model fit stored in the asreml object contained in asrtests.obj. |
| denDF | Specifies the method to use in computing approximate denominator degrees of freedom when wald.asreml is called. Can be none to suppress the computations, numeric for numerical methods, algebraic for algebraic methods or default, the default, to automattically choose numeric or algebraic computations depending on problem size. The denominator degrees of freedom are calculated according to Kenward and Roger (1997) for fixed terms in the dense part of the model. |
| dDF.na | The method to use to obtain substitute denominator degrees of freedom. when the numeric or algebraic methods produce an NA. If dDF.na = "none", no substitute denominator degrees of freedom are employed; if dDF.na = "residual", the residual degrees of freedom from asreml.obj$nedf are used; if dDF.na = "maximum", the maximum of those denDF that are available, excluding that for the Intercept, is used; if all denDF are NA, asreml.obj$nedf is used. If dDF.na = "supplied", a vector of values for the denominator degrees of freedom is to be supplied in dDF.values. Any other setting is ignored and a warning message produced. Generally, substituting these degrees of freedom is anticonservative in that it is likely that the degrees of freedom used will be too large. |

| dDF.values | A vector of values to be used when dDF.na = "supplied". Its values will be used when denDF in a test for a fixed effect is NA. This vector must be the same length as the number of fixed terms, including (Intercept) whose value could be NA. |
|---|---|
| trace | If TRUE then partial iteration details are displayed when ASReml-R functions are invoked; if FALSE then no output is displayed. |
| ... | further arguments passed to asreml and to wald.asreml. |

## Value

A wald.tab: a 4- or 6-column data.frame containing a pseudo-anova table for the fixed terms produced by wald.asreml.

## Author(s)

Chris Brien

## See Also

[as.asrtests](), [testranfix.asrtests]()

## Examples

```
## Not run:
  wald.tab <- recalcWaldTab(current.asrt,
                            dDF.na = "supplied",
                            dDF.values = c(NA,rep(c(330,346), c(4,3))))

## End(Not run)
```

---

redoErrorIntervals.alldiffs

*Adds or replaces the error intervals stored in a prediction component of an* [alldiffs.object]().

---

## Description

Given an [alldiffs.object](), adds or replaces error.intervals for its prediction component. If the backtransforms component is present, the transform.power, offset and scale will be retrieved from the backtransforms attributes, ignoring the values for the function's arguments, and the backtransformed error.intervals will also be calculated.

## Usage

```
## S3 method for class 'alldiffs'
redoErrorIntervals(alldiffs.obj, error.intervals = "Confidence",
                   alpha = 0.05, avsed.tolerance = 0.25,
                   meanLSD.type = NULL, LSDby = NULL, ...)
```

**Arguments**

| | |
|---|---|
| `alldiffs.obj` | An [alldiffs.object](). |
| `error.intervals` | |

A [character]() string indicating the type of error interval, if any, to calculate in order to indicate uncertainty in the predicted values. Possible values are "none", "StandardError", "Confidence" and "halfLeastSignificant". The default is for confidence limits to be used. The "halfLeastSignificant" option results in half the Least Significant Difference (LSD) being added and subtracted to the predictions, the LSD being calculated using the square root of the mean of the variances of all or a subset of pairwise differences between the predictions. If meanLSD.type is set to overall, the avsed.tolerance is not NA and the range of the SEDs divided by the average of the SEDs exceeds avsed.tolerance then the error.intervals calculations and the plotting will revert to confidence intervals.

| | |
|---|---|
| `alpha` | The significance level for an LSD to compare a pair of predictions. |
| `avsed.tolerance` | |

A [numeric]() giving the value of the SED range, the range of the SEDs divided by the square root of the mean of the variances of all or a subset of the pairwise differences, that is considered reasonable in calculating error.intervals. It should be a value between 0 and 1. The following rules apply:

1. If avsed.tolerance is NA then mean LSDs of the type specified by meanLSD.type are calculated and used in error.intervals and plots.
2. Irrespective of the setting of meanLSD.type, if avsed.tolerance is not exceeded then the mean LSDs are used in error.intervals and plots.
3. If meanLSD.type is set to overall, avsed.tolerance is not NA, and avsed.tolerance is exceeded then error.intervals and plotting revert to confidence intervals.
4. If meanLSD.type is set to factor.combinations and avsed.tolerance is not exceeded for any factor combination then the half LSDs are used in error.intervals and plots; otherwise, error.intervals and plotting revert to confidence intervals.
5. If meanLSD.type is set to per.prediction and avsed.tolerance is not exceeded for any prediction then the half LSDs are used in error.intervals and plots; otherwise, error.intervals and plotting revert to confidence intervals.

| | |
|---|---|
| `meanLSD.type` | A [character]() string determining whether the mean LSD stored is (i) the overall mean, based on the square root of the mean of the variances of all pairwise variances, (ii) the mean for each factor.combination of the [factor]()s specified by LSDby, which is based on the square root of the mean of the variances for all pairwise differences for each factor combination, or (iii) the per.prediction mean, based, for each prediction, on the square root of the mean of the variances for all pairwise differences involving that prediction. If NULL, the attributes meanLSD.type and LSDby of the alldiffs.obj will be used to determine the LSDs to be calculated. If the meanLSD.type attribute is NULL then meanLSD.type will be set to overall. The meanLSD.type also determines, in conjunction with avsed.tolerance, which LSD will be usedin calculating error.intervals and, hence, is used for plots. |
| `LSDby` | A [character]() (vector) of variables names, being the names of the [factor]()s or [numeric]()s in the classify for each combination of which a mean LSD, minLSD and max LSD is stored in the LSD component of the [alldiffs.object]() when meanLSD.type is factor.combinatons. |

...                      pass transform.power, offset and scale as required - for further information
                         see predictPlus.asreml.

## Value

An alldiffs.object with components predictions, vcov, differences, p.differences sed,
LSD and, if present in alldiffs.obj, backtransforms.

If error.intervals is not "none", then the predictions component and, if present, the backtransforms
component will contain columns for the lower and upper values of the limits for the interval. The
names of these columns will consist of three parts separated by full stops: 1) the first part will be
lower or upper; 2) the second part will be one of Confidence, StandardError or halfLeastSignificant;
3) the third component will be limits.

The name of the response, the term, the classify and tdf, as well as the degrees of freedom of
the standard error, will be set as attributes to the object.

## Author(s)

Chris Brien

## See Also

as.alldiffs, print.alldiffs, sort.alldiffs, subset.alldiffs,
allDifferences.data.frame, recalcLSD.alldiffs, predictPresent.asreml,
plotPredictions.data.frame, as.Date, predict.asreml

## Examples

```
data(WaterRunoff.dat)

##Use asreml to get predictions and associated statistics

## Not run:
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = pH ~ Benches + (Sources * (Type + Species)),
                      random = ~ Benches:MainPlots,
                      keep.order=TRUE, data= WaterRunoff.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
TS.diffs <- predictPlus(classify = "Sources:Type",
                        asreml.obj = current.asr,
                        wald.tab = current.asrt$wald.tab,
                       present = c("Sources", "Type", "Species"))

## End(Not run)

## Use lmeTest and emmmeans to get predictions and associated statistics

if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(pH ~ Benches + (Sources * (Type + Species)) +
                              (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  TS.emm <- emmeans::emmeans(m1.lmer, specs = ~ Sources:Species)
  TS.preds <- summary(TS.emm)
  den.df <- min(TS.preds$df, na.rm = TRUE)
```

```
   ## Modify TS.preds to be compatible with a predictions.frame
   TS.preds <- as.predictions.frame(TS.preds, predictions = "emmean",
                                    se = "SE", interval.type = "CI",
                                    interval.names = c("lower.CL", "upper.CL"))

   ## Form an all.diffs object and check its validity
   TS.vcov <- vcov(TS.emm)
   TS.diffs <- allDifferences(predictions = TS.preds,
                              classify = "Sources:Species",
                              vcov = TS.vcov, tdf = den.df)
   validAlldiffs(TS.diffs)
}

## Plot p-values for predictions obtained using asreml or lmerTest
if (exists("TS.diffs"))
{
  ##Recalculate the LSD values for predictions obtained using asreml or lmerTest
  TS.diffs <- redoErrorIntervals.alldiffs(TS.diffs,
                                          error.intervals = "halfLeastSignificant")

}
```

---

| REMLRT.asreml | *Performs a REML ratio test to compare two models.* |
| --- | --- |

---

### Description

Extracts the REML log likelihood and the number of variance parameters from two `asreml` objects. It assumes that that the first `asreml` object corresponds to the null hypothesis and the second `asreml` object to the alternative hypothesis for the test being conducted. That is, the second `asreml` object is the result of fitting a model that is a reduced version of the model for the first object. In the case where the reduced model is obtained by setting positively-constrained variance parameters in the full model to zero, the `positive.zero` argument should be set to `TRUE` so that the p-value is computed using a mixture of chi-square distributions as described in Self and Liang (1987).

The function checks that the models do not differ in either their fixed or sparse models.

### Usage

```
## S3 method for class 'asreml'
REMLRT(h0.asreml.obj, h1.asreml.obj,
      positive.zero = FALSE, bound.test.parameters = "none",
      DF = NULL, bound.exclusions = c("F","B","S","C"), ...)
```

### Arguments

| | |
| --- | --- |
| `h0.asreml.obj` | asreml object containing the fit under the model for the null hypothesis. |
| `h1.asreml.obj` | asreml object containing the fit under the model for the alternative hypothesis. |
| `positive.zero` | Indicates whether the hypothesized values for the variance components being tested are on the boundary of the parameter space. For example, this is true for positively-constrained variance components that, under the reduced model, are zero. This argument does not need to be set if `bound.test.parameters` is set. |

bound.test.parameters

> Indicates whether for the variance components being tested, at least some of the hypothesized values are on the boundary of the parameter space. The possibilities are "none", "onlybound" and "one-and-one". The default is "none", although if it is set to "none" and positive.zero is TRUE then bound.test.parameters is taken to be "onlybound". When bound.test.parameters is set to "one-and-one", it signifies that there are two parameters being tested, one of which is bound and the other is not. For example, the latter is true for testing a covariance and a positively-constrained variance component that, under the reduced model, are zero.

DF

> A numeric giving the difference between the two models in the number of variance parameters whose estimates are not of the type specified in bound.exclusions. If NULL then this is determined from the information in full.asreml.obj and reduced.asreml.obj.

bound.exclusions

> A character specifying one or more bound (constraint) codes that will result in a variance parameter being excluded from the count of estimated variance parameters. If set to NULL then none will be excluded.

...

> Provision for passsing arguments to functions called internally - not used at present.

**Value**

A data.frame containing the log of the likelihood ratio, its degrees of freedom, its p-value and the number of bound parameters in each of the two models being compared.

**Note**

If DF is not NULL, the supplied value is used. Otherwise DF is determined from the information in h1.asreml.obj and h0.asreml.obj. In this case, the degrees of freedom for the test are computed as the difference between the two models in the number of variance parameters whose estimates do not have a code for bound specified in bound.exclusions.

If ASReml-R version 4 is being used then the codes specified in bound.exclusions are not restricted to a subset of the default codes, but a warning is issued if a code other than these is specified. For ASReml-R version 3, only a subset of the default codes are allowed: F (Fixed), B (Boundary), C (Constrained) and S (Singular).

The test statistic is calculated as $2(log(REML)_1 - log(REML)_0)$.

This procedure is only approriate when the null hypothesis is that (i) all parameters are on the boundary of the parameter space (ii) all parameters are in the interior of the parameter space, or (iii) there are two parameters, one of which is on the boundary and the other is not. Other cases have been discussed by Self and Liang (1987), but are not implemented here.

**Author(s)**

Chris Brien

**References**

Self, S.G., and Liang, K-Y. (1987) Asymptotic Properties of Maximum Likelihood Estimators and Likelihood Ratio Tests Under Nonstandard Conditions. *Journal of the American Statistical Association*, **82**, 605-10.

## See Also

infoCriteria.asreml, testranfix.asrtests

## Examples

```
## Not run:
    REMLRT(ICV.max, ICV.red, bound.test.parameters = "onlybound")

## End(Not run)
```

---

renewClassify.alldiffs

> *Renews the components in an* alldiffs.object *according to a new classify.*

---

## Description

The classify is an attribute of an alldiffs.object and determines the order within the components of an unsorted alldiffs.object. This function resets the classify attribute and re-orders the components of alldiffs.object to be in standard order for the variables in a newclassify, using allDifferences.data.frame. The newclassify may be just a re-ordering of the variable names in the previous classify, or be based on a new set of variable names. The latter is particularly useful when linTransform.alldiffs has been used with a matrix and it is desired to replace the resulting Combination classify with a newclassify comprised of a more meaningful set of variables; first replace Combination in the predictions component with the new set of variables and then call renewClassify.

## Usage

```
## S3 method for class 'alldiffs'
renewClassify(alldiffs.obj, newclassify,
              sortFactor = NULL, sortWithinVals = NULL,
              sortOrder = NULL, decreasing = FALSE, ...)
```

## Arguments

| | |
|---|---|
| alldiffs.obj | An alldiffs.object. |
| newclassify | A character string giving the variables that define the margins of the multiway table that was predicted, but ordered so that the predictions are in the desired order when they are arranged in standard order for the newclassify. Multiway tables are specified by forming an interaction type term from the classifying variables, that is, separating the variable names with the : operator. The number of combined values of the set of variable name(s) must equal the number of rows in the predictions component. |
| sortFactor | A character containing the name of the factor that indexes the set of predicted values that determines the sorting of the components. If there is only one variable in the classify term then sortFactor can be NULL and the order is defined by the complete set of predicted values. If there is more than one variable in the classify term then sortFactor must be set. In this case the sortFactor is sorted for the predicted values within each combination of the values of the |

sortWithin variables: the classify variables, excluding the sortFactor. There should be only one predicted value for each unique value of sortFactor within each set defined by a combination of the values of the sortWithin variables.

sortWithinVals  A list with a component named for each factor and numeric that is a classify variable for the predictions, excluding sortFactor. Each component should contain a single value that is a value of the variable. The combination of this set of values will be used to define a subset of the predicted values whose order will define the order of sortFactor to be used for all combinations of the sortWithinVals variables. If sortWithinVals is NULL then the first value of each sortWithin variable in predictions component is used to define sortWithinVals. If there is only one variable in the classify then sortWithinVals is ignored.

sortOrder  A character vector whose length is the same as the number of levels for sortFactor in the predictions component of the alldiffs.object. It specifies the desired order of the levels in the reordered components of the alldiffs.object. The argument sortWithinVals is ignored.

The following creates a sortOrder vector levs for factor f based on the values in x: levs <-levels(f)[order(x)].

decreasing  A logical passed to order that detemines whether the order is for increasing or decreasing magnitude of the predicted values.

...  further arguments passed to allDifferences.data.frame.

## Details

First, the components of the alldiffs.object is arranged in standard order for the newclassify. Then predictions are reordered according to the settings of sortFactor, sortWithinVals, sortOrder and decreasing (see sort.alldiffs for details).

## Value

The alldiffs.object supplied with the following components, if present, sorted: predictions, vcov, backtransforms, differences, p.differences and sed. Also, the sortFactor and sortOrder attributes are set.

## Author(s)

Chris Brien

## See Also

as.alldiffs, allDifferences.data.frame, print.alldiffs, sort.alldiffs, redoErrorIntervals.alldiffs, recalcLSD.alldiffs, predictPlus.asreml, predictPresent.asreml

## Examples

```
data(WaterRunoff.dat)

##Use asreml to get predictions and associated statistics

## Not run:
#Analyse pH
m1.asr <- asreml(fixed = pH ~ Benches + (Sources * (Type + Species)),
                 random = ~ Benches:MainPlots,
```

```
                         keep.order=TRUE, data= WaterRunoff.dat)
current.asrt <- as.asrtests(m1.asr, NULL, NULL)
current.asrt <- as.asrtests(m1.asr)
current.asrt <- rmboundary(current.asrt)
m1.asr <- current.asrt$asreml.obj

#Get predictions and associated statistics
TS.diffs <- predictPlus.asreml(classify = "Sources:Type",
                               asreml.obj = m1.asr, tables = "none",
                               wald.tab = current.asrt$wald.tab,
                               present = c("Type","Species","Sources"))

## End(Not run)

## Use lmeTest and emmmeans to get predictions and associated statistics

if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  #Analyse pH
  m1.lmer <- lmerTest::lmer(pH ~ Benches + (Sources * (Type + Species)) +
                                  (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  TS.emm <- emmeans::emmeans(m1.lmer, specs = ~ Sources:Type)
  TS.preds <- summary(TS.emm)
  den.df <- min(TS.preds$df, na.rm = TRUE)
  ## Modify TS.preds to be compatible with a predictions.frame
  TS.preds <- as.predictions.frame(TS.preds, predictions = "emmean",
                                   se = "SE", interval.type = "CI",
                                   interval.names = c("lower.CL", "upper.CL"))

  ## Form an all.diffs object and check its validity
  TS.vcov <- vcov(TS.emm)
  TS.diffs <- allDifferences(predictions = TS.preds,
                             classify = "Sources:Type",
                             vcov = TS.vcov, tdf = den.df)
  validAlldiffs(TS.diffs)
}

#Re-order predictions from asreml or lmerTest so all Sources for the same Type are together
#for each combination of A and B
if (exists("TS.diffs"))
{
  TS.diffs.reord <- renewClassify(TS.diffs, newclassify = "Type:Sources")
  validAlldiffs(TS.diffs.reord)
}
```

---

reparamSigDevn.asrtests

> *Reparamterizes each random (deviations) term involving* devn.fac *to a fixed term and ensures that the same term, with* trend.num *replacing* devn.fac, *is included if any other term with* trend.num *is included in* terms.

---

## Description

This function reparamterizes each random (deviations) term involving devn.fac to a fixed term and ensures that the same term with trend.num replacing devn.fac is included if any other term with trend.num is included in terms. It also ansures that any term with spl{trend.num} replacing devn.fac in a term being reparameterized is removed from the model.

## Usage

```
## S3 method for class 'asrtests'
reparamSigDevn(asrtests.obj,terms = NULL,
               trend.num = NULL, devn.fac = NULL,
               allow.unconverged = TRUE, checkboundaryonly = FALSE,
               denDF = "numeric", trace = FALSE, update = TRUE,
               set.terms = NULL, ignore.suffices = TRUE,
               bounds = "P", initial.values = NA,...)
```

## Arguments

asrtests.obj    an asrtests.object containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary.

terms           A character string vector giving the terms that are to be reparameterized.

trend.num       A character string giving the name of the numeric covariate that corresponds to devn.fac and is potentially included in terms in the fitted model.

devn.fac        A character string giving the name of the factor that corresponds to trend.num and is included in terms in the fitted model.

allow.unconverged

A logical indicating whether to accept a new model even when it does not converge. Initially all changes are made with allow.unconverged set to TRUE. If allow.unconverged has been set to FALSE in the call and the final fit does not converge, an attempt is made to achieve convergence by removing any boundary terms. If this is unsuccessful, the supplied asrtsts object is returned.

checkboundaryonly

If TRUE then boundary and singular terms are not removed by rmboundary.asrtests; a warning is issued instead.

denDF           Specifies the enthod to use in computing approximate denominator degrees of freedom when wald.asreml is called. Can be none to suppress the computations, numeric for numerical methods, algebraic for algebraic methods or default, the default, to autommatically choose numeric or algebraic computations depending on problem size. The denominator degrees of freedom are calculated according to Kenward and Roger (1997) for fixed terms in the dense part of the model.

trace           If TRUE then partial iteration details are displayed when ASReml-R functions are invoked; if FALSE then no output is displayed.

update          If TRUE then update.asreml is called in removing and adding terms to the model. In doing this the arguments R.param and G.param are set to those in the asreml object stored in the supplied asrtests.obj so that the values from the previous model are used as starting values. If FALSE then calls are made to asreml in which the only changes from the previous call are (i) that the models are updated and (ii) modifications specified via ... are made.

set.terms          A character vector specifying the terms that are to have bounds and/or initial
                   values set prior to fitting.

ignore.suffices

                   A logical vector specifying whether the suffices of the asreml-assigned names
                   of the variance terms (i.e. the information to the right of an "!", other than
                   "R!") is to be ignored in matching elements of terms. If TRUE for an element
                   of terms, the suffices are stripped from the asreml-assigned names. If FALSE
                   for an element of terms, the element must exactly match an asreml-assigned
                   name for a variance term. This vector must be of length one or the same length
                   as terms. If it is of length one then the same action is applied to the asreml-
                   assigned suffices for all the terms in terms.

bounds             A [character](#) vector specifying the bounds to be applied to the terms speci-
                   fied in set.terms. This vector must be of length one or the same length as
                   set.terms. If it is of length one then the same constraint is applied to all the
                   terms in set.terms. If any of the bounds are equal to NA then they are left
                   unchanged for those terms.

initial.values     A character vector specifying the initial values for the terms specified in terms.
                   This vector must be of length one or the same length as terms. If it is of length
                   one then the same initial value is applied to all the terms in terms. If any of the
                   initial.values are equal to NA then they are left unchanged for those terms.

...                further arguments passed to asreml via [changeTerms.asrtests](#) and [as.asrtests](#).

## Value

An [asrtests.object](#) containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary.

## Author(s)

Chris Brien

## See Also

[as.asrtests](#), [changeTerms.asrtests](#), [testranfix.asrtests](#), [testresidual.asrtests](#),
[newfit.asreml](#), [chooseModel.asrtests](#)

## Examples

```
## Not run:
  data(WaterRunoff.dat)
  asreml.options(keep.order = TRUE) #required for asreml-R4 only
  current.asr <- asreml(fixed = log.Turbidity ~ Benches + Sources + Type + Species +
                             Sources:Type + Sources:Species + Sources:Species:xDay +
                             Sources:Species:Date,
                          data = WaterRunoff.dat, keep.order = TRUE)
  current.asrt <- as.asrtests(current.asr, NULL, NULL)

  #Examine terms that describe just the interactions of Date and the treatment factors
  terms.treat <- c("Sources", "Type", "Species", "Sources:Type", "Sources:Species")
  date.terms <- sapply(terms.treat,
                       FUN=function(term){paste("Date:",term,sep="")},
                       simplify=TRUE)
  date.terms <- c("Date", date.terms)
  date.terms <- unname(date.terms)
  treat.marginality <-  matrix(c(1,0,0,0,0,0, 1,1,0,0,0,0,  1,0,1,0,0,0,
```

```
                                           1,0,1,1,0,0, 1,1,1,0,1,0, 1,1,1,1,1,1), nrow=6)
rownames(treat.marginality) <- date.terms
colnames(treat.marginality) <- date.terms
choose <- chooseModel(current.asrt, treat.marginality, denDF="algebraic")
current.asrt <- choose$asrtests.obj
current.asr <- current.asrt$asreml.obj
sig.date.terms <- choose$sig.terms

#Remove all Date terms left in the fixed model
terms <- "(Date/(Sources * (Type + Species)))"
current.asrt <- changeTerms(current.asrt, dropFixed = terms)
#if there are significant date terms, reparameterize to xDays + spl(xDays) + Date
if (length(sig.date.terms) != 0)
{ #add lin + spl + devn for each to fixed and random models
  trend.date.terms <- sapply(sig.date.terms,
                              FUN=function(term){sub("Date","xDay",term)},
                              simplify=TRUE)
  trend.date.terms <- paste(trend.date.terms,  collapse=" + ")
  current.asrt <- changeTerms(current.asrt, addFixed=trend.date.terms)
  trend.date.terms <- sapply(sig.date.terms,
                              FUN=function(term){sub("Date","spl(xDay)",term)},
                              simplify=TRUE)
  trend.date.terms <- c(trend.date.terms, sig.date.terms)
  trend.date.terms <- paste(trend.date.terms,  collapse=" + ")
  current.asrt <- changeTerms(current.asrt, addRandom = trend.date.terms)
  current.asrt <- rmboundary(current.asrt)
}

#Now test terms for sig date terms
spl.terms <- sapply(terms.treat,
                     FUN=function(term){paste("spl(xDay):",term,sep="")},
                     simplify=TRUE)
spl.terms <- c("spl(xDay)",spl.terms)
lin.terms <- sapply(terms.treat,
                     FUN=function(term){paste(term,":xDay",sep="")},
                     simplify=TRUE)
lin.terms <- c("xDay",lin.terms)
systematic.terms <- c(terms.treat, lin.terms, spl.terms, date.terms)
systematic.terms <- unname(systematic.terms)
treat.marginality <-  matrix(c(1,0,0,0,0,0, 1,1,0,0,0,0,  1,0,1,0,0,0,
                                 1,0,1,1,0,0, 1,1,1,1,1,0, 1,1,1,1,1,1), nrow=6)
systematic.marginality <- kronecker(matrix(c(1,0,0,0, 1,1,0,0,
                                               1,1,1,0, 1,1,1,1), nrow=4),
                                      treat.marginality)
systematic.marginality <- systematic.marginality[-1, -1]
rownames(systematic.marginality) <- systematic.terms
colnames(systematic.marginality) <- systematic.terms
choose <- chooseModel(current.asrt, systematic.marginality,
                        denDF="algebraic", pos=TRUE)
current.asrt <- choose$asrtests.obj

#Check if any deviations are significant and, for those that are, go back to
#fixed dates
current.asrt <- reparamSigDevn(current.asrt, choose$sig.terms,
                                trend.num = "xDay", devn.fac = "Date",
                                denDF = "algebraic")
```

```
## End(Not run)
```

---

| | |
|---|---|
| rmboundary.asrtests | *Removes any boundary or singular variance components from the fit stored in* asrtests.obj *and records their removal in an* [asrtests.object](). |

---

### Description

Any terms specified in the random model that are estimated on the boundary or are singular and can be removed are removed from the fit stored in the asreml object stored in the [asrtests.object](). Terms that specify multiple parameters in the random model cannot be removed (e.g. terms specified using the at function with more than one level of the factor) and terms in residual model are not removed. Terms that can be removed are selected for removal in the following order based on whether they involve: (i) a dev function, (ii) only factors, (iii) an spl function, (iv) a pol function and (v) a lin function or a variable that is an integer or a numeric. It should be noted that this order of removal presumes that random deviation terms are specified via the dev function rather than via a random factor. Once the earliest of the above classes with a boundary term is identified, a term within this class is selected for removal. For all classes, except for factor-only terms, the smallest term with the largest number of variables/factors is removed. Amongst factor-only terms, the smallest term with the smallest number of variables/factors is removed. After each variance component is removed, a row for it is added to the test.summary data.frame and the model re-fitted. If there are further boundary or singular terms, one is removed using the above strategy. This process continues until there are no further boundary or singular variance components that are removable. Other types of boundary or singular terms, which cannot be removed, are reported in warning messages.

### Usage

```
## S3 method for class 'asrtests'
rmboundary(asrtests.obj, checkboundaryonly = FALSE,
          trace = FALSE, update = TRUE,
          set.terms = NULL, ignore.suffices = TRUE,
          bounds = "P", initial.values = NA, ...)
```

### Arguments

asrtests.obj    an [asrtests.object]() containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary.

checkboundaryonly

If TRUE then boundary and singular terms are not removed by [rmboundary.asrtests](); a warning is issued instead.

trace           If TRUE then partial iteration details are displayed when ASReml-R functions are invoked; if FALSE then no output is displayed.

update          If TRUE then update.asreml is called to fit the model with any boundary terms removed. In doing this the arguments R.param and G.param are set to those in the asreml object stored in asrtests.obj so that the values from the previous model are used as starting values. If FALSE then a call is made to asreml in which the only changes from the previous call are that (i) the terms for boundary variance components are removed from the models and (ii) modifications specified via ... are made.

set.terms          A character vector specifying the terms that are to have bounds and/or initial
                   values set prior to fitting.

ignore.suffices

                   A logical vector specifying whether the suffices of the asreml-assigned names
                   of the variance terms (i.e. the information to the right of an "!", other than
                   "R!") is to be ignored in matching elements of terms. If TRUE for an element
                   of terms, the suffices are stripped from the asreml-assigned names. If FALSE
                   for an element of terms, the element must exactly match an asreml-assigned
                   name for a variance term. This vector must be of length one or the same length
                   as terms. If it is of length one then the same action is applied to the asreml-
                   assigned suffices for all the terms in terms.

bounds             A [character](character) vector specifying the bounds to be applied to the terms speci-
                   fied in set.terms. This vector must be of length one or the same length as
                   set.terms. If it is of length one then the same constraint is applied to all the
                   terms in set.terms. If any of the bounds are equal to NA then they are left
                   unchanged for those terms.

initial.values     A character vector specifying the initial values for the terms specified in terms.
                   This vector must be of length one or the same length as terms. If it is of length
                   one then the same initial value is applied to all the terms in terms. If any of the
                   initial.values are equal to NA then they are left unchanged for those terms.

...                further arguments passed to asreml.

## Value

An [asrtests.object](asrtests.object) containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary.

## Author(s)

Chris Brien

## See Also

[as.asrtests](as.asrtests), [changeTerms.asrtests](changeTerms.asrtests), [testranfix.asrtests](testranfix.asrtests), [testresidual.asrtests](testresidual.asrtests),
[newfit.asreml](newfit.asreml), [reparamSigDevn.asrtests](reparamSigDevn.asrtests), [chooseModel.asrtests](chooseModel.asrtests)

## Examples

```
## Not run:
current.asrt <- rmboundary(current.asrt)

## End(Not run)
```

---

setvarianceterms.call  *allows the setting of bounds and initial values for terms in the* random
                       *and* residual *arguments of an* asreml *call, with the resulting call
                       being evaluated.*

---

**Description**

Takes an unevaluated `call` and evaluates the `call` after setting the bounds and initial values for the terms specified in `terms`. The elements of `terms` are matched with those generated by asreml and used, for example, in the `varcomp` component of a `summary.asreml` object. These names generally include descriptive suffices. To match an element of `terms` that includes such a suffix, set `ignore.suffices` to `FALSE` so that a literal match between the element and the assigned names is sought.

**Usage**

```
## S3 method for class 'call'
setvarianceterms(call, terms, ignore.suffices = TRUE,
                 bounds = "P", initial.values = NA, ...)
```

**Arguments**

| | |
|---|---|
| `call` | an unevaluated `call` to `asreml`. One way to create such a `call` is to use the `call` function with its `name` argument set to `"asreml"`. Another is to obtain it from the `call` component of an asreml object (e.g. `call <-asreml.obj$call`). |
| `terms` | A character vector specifying the terms that are to have bounds and/or initial values specified. |
| `ignore.suffices` | A logical vector specifying whether the suffices of the `asreml`-assigned names of the variance terms (i.e. the information to the right of an "!", other than "R!") is to be ignored in matching elements of `terms`. If `TRUE` for an element of `terms`, the suffices are stripped from the `asreml`-assigned names. If `FALSE` for an element of `terms`, the element must exactly match an `asreml`-assigned name for a variance term. This vector must be of length one or the same length as `terms`. If it is of length one then the same action is applied to the `asreml`-assigned suffices for all the terms in `terms`. |
| `bounds` | A [character](#) vector specifying the bounds to be applied to the terms specified in `set.terms`. This vector must be of length one or the same length as `set.terms`. If it is of length one then the same constraint is applied to all the terms in `set.terms`. If any of the bounds are equal to NA then they are left unchanged for those terms. |
| | The codes used by ASReml are: |
| | • B - fixed at a boundary; |
| | • F - fixed by the user; |
| | • P - positive definite; |
| | • C - Constrained by user; |
| | • U - unbounded. |
| `initial.values` | A character vector specifying the initial values for the terms specified in `terms`. This vector must be of length one or the same length as `terms`. If it is of length one then the same initial value is applied to all the terms in `terms`. If any of the initial.values are equal to NA then they are left unchanged for those terms. |
| `...` | additional arguments to be added to the call, or arguments in the call with changed values. |

**Value**

An `asreml` object.

**Author(s)**

Chris Brien

**References**

Butler, D. G., Cullis, B. R., Gilmour, A. R., Gogel, B. J. and Thompson, R. (2018). *ASReml-R Reference Manual Version 4.* VSN International Ltd, <http://asreml.org>.

**See Also**

update.asreml

**Examples**

```
## Not run:
   m1.call <- call("asreml",
                   fixed = Height ~ (Block + Irrig)*csDay.num,
                   random= ~ spl(csDay.num)/(Irrig+Block)
                           + dev(csDay.num)
                           + str(~Block:Plot/csDay.num, ~us(2):id(20))
                           + Block:Plot:spl(csDay.num),
                   data=quote(dat)) ##use quote to stop evaluation of dat here
   terms <- c("Block:Plot+Block:Plot:csDay.num!us(2).2:1", "R!variance")
   m1.asreml <- setvarianceterms(m1.call, terms, bounds=c("U","P"),
                                 initial=c(NA,3), ignore.suffices=c(FALSE,TRUE))
   summary(m1.asreml)

## End(Not run)
```

---

| simulate.asreml | *Produce sets of simulated data from a multivariate normal distribtion and save quantites related to the simulated data* |
|---|---|

---

**Description**

Produce in parallel sets of simulated data corresponding to an asreml model, along with its fitted values and residuals. A variance matrix V, corresponding to the random and residual models must be supplied. What to save is specified by the which argument.

**Usage**

```
## S3 method for class 'asreml'
simulate(object, nsim=100, seed = NULL, means=NULL, V, tolerance = 1E-10,
         update = TRUE, trace = FALSE, which="data", units = "ignore",
         ncores = detectCores(), ...)
```

**Arguments**

| | |
|---|---|
| object | An asreml object from a call to asreml in which the data argument has been set. |
| means | The vector of means to be used in generating simulated data sets. If it is NULL, the fitted values based on object are used. It must be the same length as the response variable for object. |

| V | The fitted variance matrix, i.e. having the pattern and values that conform to the model fit stored in the supplied object. |
|---|---|
| nsim | The number of data sets to be simulated. |
| seed | A single value, interpreted as an integer, that specifies the starting value of the random number generator. The "L'Ecuyer-CMRG" random generator is used and nextRNGStream is used to seed each core from the original seed. |
| tolerance | The value such that eigenvalues less than it are considered to be zero. |
| update | If TRUE then the arguments R.param and G.param are set to those in the asreml object supplied in object so that the values from the original model are used as starting values. If FALSE then calls are made to asreml in which the only changes from the previous call are (i) the model is fitted to simulated data and (ii) modifications specified via ... are made, except that changes cannot be made to any of the models. |
| trace | If TRUE then partial iteration details are displayed when ASReml-R functions are invoked; if FALSE then no output is displayed. |
| which | The quantites from the simulated data set to be stored. Any combination of "response", "residuals" and "fitted", or "all". If residuals and/or fitted is specified, those for the analysis stored in object will be added to the data.frame nominated in the data argument of object and the modified data.frame added as a component named data in the list that is the value returned by the function. |
| units | A character indicating whether the BLUPs for units are added to the residuals when this reserved factor is included in the random model. Possible values are addtoresiduals and ignore. |
| ncores | A numeric specifying the number of cores to use in doing the simulations. |
| ... | Other arguments that are passed down to the function asreml. Changes to the models are not allowed. Other changes are dangerous and generally should be avoided. |

## Details

Generate nsim sets of data and analyse them using asreml using the model in object, performing the generation and analysis of several sets in parallel. Note, if the analysis for a data set does not converge in maxiter iterations, it is discarded and a replacement data set generated. The value of maxiter can be specified in the call to simulate.asreml. The fitted values and residuals are extracted as required. If aom = TRUE when the simulated data are analysed, standardised conditional residuals are stored. If which includes residuals or fitted, the specified quantities for the observed data are added to the data.frame on which the fit in object is based.

## Value

A list with the following components whose presence depends on the setting of which:

1. **observed:** present if which includes residuals or fitted, in which case it will be the data.frame on which the fit in object is based, with residuals and/or fitted.

2. **data:** present if which includes data, a data.frame containing the simulated data sets.

3. **fitted:** present if which includes fitted, a data.frame containing the fitted values from the analyses of the simulated data sets.

4. **residuals:** present if which includes residuals, a data.frame containing the residuals from the analyses of the simulated data sets.

**Author(s)**

Chris Brien

**See Also**

asreml, `variofaces.asreml`, `plotVariofaces.data.frame`, `set.seed`.

**Examples**

```
## Not run:
data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary.asrtests(current.asrt)
# Form variance matrix based on estimated variance parameters
s2 <- current.asr$sigma2
gamma.Row <- current.asr$gammas[1]
gamma.unit <- current.asr$gammas[2]
rho.r <- current.asr$gammas[4]
rho.c <- current.asr$gammas[5]
row.ar1 <- mat.ar1(order=10, rho=rho.r)
col.ar1 <- mat.ar1(order=15, rho=rho.c)
V <- gamma.Row * fac.sumop(Wheat.dat$Row) +
     gamma.unit * diag(1, nrow=150, ncol=150) +
     mat.dirprod(col.ar1, row.ar1)
V <- s2*V

#Produce residuals from 100 simulated data sets
resid <- simulate(current.asr, V=V, which="residuals", ncores = 2)

## End(Not run)
```

---

sort.alldiffs            *Sorts the components in an* `alldiffs.object` *according to the pre-dicted values associated with a factor.*

---

**Description**

Sorts the rows of the components in an `alldiffs.object` (see `as.alldiffs`) that are data.frames and the rows and columns of those that are matrices according to the predicted values in the predictions component. These predicted values are generally obtained using predict.asreml by specifying a classify term comprised of one or more variables. Generally, the values associated with one variable are sorted in parallel within each combination of values of the other variables. When there is more than one variable in the classify term, the sorting is controlled using one or more of sortFactor, sortWithinVals and sortOrder. If there is only one variable in the classify then all components are sorted according to the order of the complete set of predictions.

Note that reordering the classify variables in the `alldiffs.object` and changing the order of the rows and columns of the components so that they are in standard order for the new variable order can be achieved using either `renewClassify.alldiffs` or `allDifferences.data.frame`.

## Usage

```
## S3 method for class 'alldiffs'
sort(x, decreasing = FALSE, classify = NULL,
     sortFactor = NULL, sortWithinVals = NULL, sortOrder = NULL, ...)
```

## Arguments

| | |
|---|---|
| x | An alldiffs.object. |
| decreasing | A logical passed to order that detemines whether the order is for increasing or decreasing magnitude of the predicted values. |
| classify | A character string giving the variables that define the margins of the multiway table that was predicted. Multiway tables are specified by forming an interaction type term from the classifying variables, that is, separating the variable names with the : operator. If NULL, it will be obtained from the classify attribute of the as.alldiffs object supplied through x. |
| sortFactor | A character containing the name of the factor that indexes the set of predicted values that determines the sorting of the components. If there is only one variable in the classify term then sortFactor can be NULL and the order is defined by the complete set of predicted values. If there is more than one variable in the classify term then sortFactor must be set. In this case the sortFactor is sorted in the same order within each combination of the values of the sortWithin variables: the classify variables, excluding the sortFactor. There should be only one predicted value for each unique value of sortFactor within each set defined by a combination of the values of the sortWithin variables. The order to use is determined by either sortWithinVals or sortOrder. |
| sortWithinVals | A list with a component named for each factor and numeric that is a classify variable for the predictions, excluding sortFactor. Each component should contain a single value that is a value of the variable. The combination of this set of values will be used to define a subset of the predicted values whose order will define the order of sortFactor to be used for all combinations of the sortWithinVals variables. If sortWithinVals is NULL then the first value of each sortWithin variable in predictions component is used to define sortWithinVals. If there is only one variable in the classify then sortWithinVals is ignored. |
| sortOrder | A character vector whose length is the same as the number of levels for sortFactor in the predictions component of the alldiffs.object. It specifies the desired order of the levels in the reordered components of the alldiffs.object. The argument sortWithinVals is ignored.<br><br>The following creates a sortOrder vector levs for factor f based on the values in x: levs <-levels(f)[order(x)]. |
| ... | further arguments passed to or from other methods. Not used at present. |

## Details

The basic technique is to change the order of the levels of the sortFactor within the predictions and, if present, backtransforms components so that they are ordered for a subset of predicted values, one for each levels of the sortFactor. When the classify term consists of more than one variable then a subset of one combination of the values of variables other than the sortFactor, the sortWithin set, must be chosen for determining the order of the sortFactor levels. Then the sorting of the rows (and columns) will be in parallel within each combination of the values of sortWithin variables: the classify term, excluding the sortFactor.

**Value**

The `alldiffs.object` supplied with the following components, if present, sorted: `predictions`, `vcov`, `backtransforms`, `differences`, `p.differences` and `sed`. Also, the `sortFactor` and `sortOrder` attributes are set.

**Author(s)**

Chris Brien

**See Also**

`as.alldiffs`, `allDifferences.data.frame`, `print.alldiffs`, `renewClassify.alldiffs`, `redoErrorIntervals.alldiffs`, `recalcLSD.alldiffs`, `predictPlus.asreml`, `predictPresent.asreml`

**Examples**

```
data(WaterRunoff.dat)

##Use asreml to get predictions and associated statistics

## Not run:
#Analyse pH
m1.asr <- asreml(fixed = pH ~ Benches + (Sources * (Type + Species)),
                 random = ~ Benches:MainPlots,
                 keep.order=TRUE, data= WaterRunoff.dat)
current.asrt <- as.asrtests(m1.asr, NULL, NULL)
current.asrt <- as.asrtests(m1.asr)
current.asrt <- rmboundary(current.asrt)
m1.asr <- current.asrt$asreml.obj

#Get predictions and associated statistics
TS.diffs <- predictPlus.asreml(classify = "Sources:Type",
                               asreml.obj = m1.asr, tables = "none",
                               wald.tab = current.asrt$wald.tab,
                               present = c("Type","Species","Sources"))

#Use sort.alldiffs and save order for use with other response variables
TS.diffs.sort <- sort(diffs, sortFactor = "Sources", sortWithinVals = list(Type = "Control"))
sort.order <- attr(TS.diffs.sort, which = "sortOrder")

#Analyse Turbidity
m2.asr <- asreml(fixed = Turbidity ~ Benches + (Sources * (Type + Species)),
                 random = ~ Benches:MainPlots,
                 keep.order=TRUE, data= WaterRunoff.dat)
current.asrt <- as.asrtests(m2.asr)
#Use pH sort.order to sort Turbidity alldiffs object
diffs2.sort <- predictPlus(m2.asr, classify = "Sources:Type",
                           pairwise = FALSE, error.intervals = "Stand",
                           tables = "none", present = c("Type","Species","Sources"),
                           sortFactor = "Sources",
                           sortOrder = sort.order)

## End(Not run)

## Use lmeTest and emmmeans to get predictions and associated statistics
```

```
if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  #Analyse pH
  m1.lmer <- lmerTest::lmer(pH ~ Benches + (Sources * (Type + Species)) +
                              (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  TS.emm <- emmeans::emmeans(m1.lmer, specs = ~ Sources:Type)
  TS.preds <- summary(TS.emm)
  den.df <- min(TS.preds$df, na.rm = TRUE)
  ## Modify TS.preds to be compatible with a predictions.frame
  TS.preds <- as.predictions.frame(TS.preds, predictions = "emmean",
                                   se = "SE", interval.type = "CI",
                                   interval.names = c("lower.CL", "upper.CL"))

  ## Form an all.diffs object and check its validity
  TS.vcov <- vcov(TS.emm)
  TS.diffs <- allDifferences(predictions = TS.preds,
                             classify = "Sources:Type",
                             vcov = TS.vcov, tdf = den.df)
  validAlldiffs(TS.diffs)

  #Use sort.alldiffs and save order for use with other response variables
  TS.diffs.sort <- sort(TS.diffs, sortFactor = "Sources",
                        sortWithinVals = list(Type = "Control"))
  sort.order <- attr(TS.diffs.sort, which = "sortOrder")

  #Analyse Turbidity
  m2.lmer <- lmerTest::lmer(Turbidity ~ Benches + (Sources * (Type + Species)) +
                              (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  TS.emm <- emmeans::emmeans(m2.lmer, specs = ~ Sources:Type)
  TS.preds <- summary(TS.emm)
  den.df <- min(TS.preds$df, na.rm = TRUE)
  ## Modify TS.preds to be compatible with a predictions.frame
  TS.preds <- as.predictions.frame(TS.preds, predictions = "emmean",
                                   se = "SE", interval.type = "CI",
                                   interval.names = c("lower.CL", "upper.CL"))

  ## Form an all.diffs object, sorting it using the pH sort.order and check its validity
  TS.vcov <- vcov(TS.emm)
  TS.diffs2.sort <- allDifferences(predictions = TS.preds,
                                   classify = "Sources:Type",
                                   vcov = TS.vcov, tdf = den.df,
                                   sortFactor = "Sources",
                                   sortOrder = sort.order)
  validAlldiffs(TS.diffs2.sort)
}
```

---

subset.alldiffs          *Subsets the components in an* `alldiffs.object` *according to the supplied condition.*

---

**Description**

Subsets each of the components of an `alldiffs.object`. The subset is determined by applying the condition to the `prediction` component to determine which of its rows are to be included in the subset. Then, if present, this subset is applied to the rows of `backtransforms` and to the rows and columns of `differences`, `p.differences` and `sed` components. In addition, if `sed` is present, `recalcLSD.alldiffs` is called to recalculate the values in the LSD component, with any arguments supplied via the ... argument passed ot it.

The `select` argument of subset is not implemented, but can be achieved for variables in the `classify` using the rmClassifyVars argument.

**Usage**

```
## S3 method for class 'alldiffs'
subset(x, subset = rep(TRUE, nrow(x$predictions)),
       rmClassifyVars = NULL, ...)
```

**Arguments**

| | |
|---|---|
| x | An `alldiffs.object`. |
| subset | A `logical` that detemines rows of the `predictions` component of x to be included in the subset. By default allws are included. |
| rmClassifyVars | A `character` that contains the names of the variables in the `classify` attribute of x that are to be removed from the predictions `data.frame` and the names of the dimensions of the other components of x. In doing this, the combinations of the remaining `classify` variables must uniquely index the predictions. |
| ... | further arguments passed to `recalcLSD.alldiffs`. |

**Value**

An `alldiffs.object` with the following components of the supplied `alldiffs.object` subsetted, if present in the original object: predictions, vcov, backtransforms, differences, p.differences and sed. In addition, if sed is present, the LSD component will be recalculated.

**Author(s)**

Chris Brien

**See Also**

`as.alldiffs`, `allDifferences.data.frame`, `print.alldiffs`, `sort.alldiffs`, `redoErrorIntervals.alldiffs`, `recalcLSD.alldiffs`, `predictPlus.asreml`, `predictPresent.asreml`

**Examples**

```
data(WaterRunoff.dat)

##Use asreml to get predictions and associated statistics

## Not run:
asreml.options(keep.order = TRUE) #required for asreml-R4 only
current.asr <- asreml(fixed = pH ~ Benches + (Sources * (Type + Species)),
                      random = ~ Benches:MainPlots,
```

```
                          keep.order=TRUE, data= WaterRunoff.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
TS.diffs <- predictPlus.asreml(classify = "Sources:Type",
                               asreml.obj = current.asr, tables = "none",
                               wald.tab = current.asrt$wald.tab,
                               present = c("Type","Species","Sources"))

## End(Not run)

## Use lmeTest and emmmeans to get predictions and associated statistics

if (requireNamespace("lmerTest", quietly = TRUE) &
    requireNamespace("emmeans", quietly = TRUE))
{
  m1.lmer <- lmerTest::lmer(pH ~ Benches + (Sources * (Type + Species)) +
                              (1|Benches:MainPlots),
                            data=na.omit(WaterRunoff.dat))
  TS.emm <- emmeans::emmeans(m1.lmer, specs = ~ Sources:Type)
  TS.preds <- summary(TS.emm)
  den.df <- min(TS.preds$df, na.rm = TRUE)
  ## Modify TS.preds to be compatible with a predictions.frame
  TS.preds <- as.predictions.frame(TS.preds, predictions = "emmean",
                                   se = "SE", interval.type = "CI",
                                   interval.names = c("lower.CL", "upper.CL"))

  ## Form an all.diffs object and check its validity
  TS.vcov <- vcov(TS.emm)
  TS.diffs <- allDifferences(predictions = TS.preds, classify = "Sources:Type",
                             vcov = TS.vcov, tdf = den.df)
  validAlldiffs(TS.diffs)
}

## Plot p-values for predictions obtained using asreml or lmerTest
if (exists("TS.diffs"))
{
  ##Use subset.alldiffs to select a subset of the alldiffs object
  TS.diffs.subs <- subset(TS.diffs,
                          subset = grepl("R", Sources, fixed = TRUE) &
                                     Type %in% c("Control","Medicinal"))
}
```

---

testranfix.asrtests     *Tests for a single fixed or random term in model fitted using* asreml
                        *and records the result in an* asrtests.object.

---

### Description

Tests for a single term, using a REML LRT for a random term or based on Wald statistics for a fixed
term. The term must be in the fitted model. A random term is removed from the model fit and a
REML likelihood ratio test is performed using REMLRT.asreml. It compares the fit of the model in
asreml.obj and the newly fitted model without the term. If the newly fitted model is retained, any
boundary terms are then removed using rmboundary.asrtests. For a fixed term, the probability
of the Wald statistics is extracted from the pseudo-anova table produced by wald.asreml. If this
is available in the asrtests.object, it is used; otherwise wald.asreml is called to add it to the

[asrtests.object](). Whether nonsignificant terms are dropped is controlled by drop.ran.ns for
random terms and drop.fix.ns for fixed terms. A row is added to the test.summary data.frame
for the term that is tested.

## Usage

```
## S3 method for class 'asrtests'
testranfix(asrtests.obj, term=NULL, alpha = 0.05,
           allow.unconverged = TRUE, checkboundaryonly = FALSE,
           drop.ran.ns = TRUE, positive.zero = FALSE,
           bound.test.parameters = "none",
           bound.exclusions = c("F","B","S","C"), REMLDF = NULL,
           drop.fix.ns = FALSE, denDF="numeric", dDF.na = "none",
           dDF.values = NULL, trace = FALSE, update = TRUE,
           set.terms = NULL, ignore.suffices = TRUE,
           bounds = "P", initial.values = NA, ...)
```

## Arguments

asrtests.obj     An [asrtests.object]() containing the components (i) asreml.obj, (ii) wald.tab,
                 and (iii) test.summary.

term             A single model term that is valid in asreml, stored as a character.

alpha            The significance level for the test.

allow.unconverged

                 A logical indicating whether to accept a new model even when it does not
                 converge. If FALSE, it will be checked whether convergence can be achieved
                 with the removal of any boundary random terms; random terms will be retested
                 if terms are removed. Also, if FALSE and the fit of the new model has converged,
                 but that of the old model has not, the new model will be accepted.

checkboundaryonly

                 If TRUE then boundary and singular terms are not removed by [rmboundary.asrtests]();
                 a warning is issued instead.

drop.ran.ns      A logical indicating whether to drop a random term from the model when it is
                 nonsignificant.

positive.zero    Indicates whether the hypothesized values for the variance components being
                 tested are on the boundary of the parameter space. For example, this is true for
                 positively-constrained variance components that, under the reduced model, are
                 zero. This argument does not need to be set if bound.test.parameters is set.

bound.test.parameters

                 Indicates whether for the variance components being tested, at least some of the
                 hypothesized values are on the boundary of the parameter space. The possibili-
                 ties are "none", "onlybound" and "one-and-one". The default is "none", al-
                 though if it is set to "none" and positive.zero is TRUE then bound.test.parameters
                 is taken to be "onlybound". When bound.test.parameters is set to "one-and-one",
                 it signifies that there are two parameters being tested, one of which is bound and
                 the other is not. For example, the latter is true for testing a covariance and a
                 positively-constrained variance component that, under the reduced model, are
                 zero.

bound.exclusions

                 A character specifying one or more bound (constraint) codes that will result
                 in a variance parameter being excluded from the count of estimated variance
                 parameters in using [REMLRT.asreml](). If set to NULL then none will be excluded.

| | |
|---|---|
| REMLDF | A numeric giving the difference in the number of variance parameters whose estimates are not of the type specified in bound.exclusions for two models being compared in a REML ratio test using REMLRT.asreml. If NULL then this is determined from the information in the asreml object for the two models. |
| drop.fix.ns | A logical indicating whether to drop a fixed term from the model when it is nonsignificant |
| denDF | Specifies the enthod to use in computing approximate denominator degrees of freedom when wald.asreml is called. Can be none to suppress the computations, numeric for numerical methods, algebraic for algebraic methods or default, the default, to autommatically choose numeric or algebraic computations depending on problem size. The denominator degrees of freedom are calculated according to Kenward and Roger (1997) for fixed terms in the dense part of the model. |
| dDF.na | The method to use to obtain substitute denominator degrees of freedom. when the numeric or algebraic methods produce an NA. If dDF.na = "none", no subtitute denominator degrees of freedom are employed; if dDF.na = "residual", the residual degrees of freedom from asreml.obj$nedf are used; if dDF.na = "maximum", the maximum of those denDF that are available, excluding that for the Intercept, is used; if all denDF are NA, asreml.obj$nedf is used. If dDF.na = "supplied", a vector of values for the denominator degrees of freedom is to be supplied in dDF.values. Any other setting is ignored and a warning message produced. Generally, substituting these degrees of freedom is anticonservative in that it is likely that the degrees of freedom used will be too large. |
| dDF.values | A vector of values to be used when dDF.na = "supplied". Its values will be used when denDF in a test for a fixed effect is NA. This vector must be the same length as the number of fixed terms, including (Intercept) whose value could be NA. |
| trace | If TRUE then partial iteration details are displayed when ASReml-R functions are invoked; if FALSE then no output is displayed. |
| update | If TRUE then update.asreml is called to fit the model to be tested. In doing this the arguments R.param and G.param are set to those in the asreml object stored in asrtests.obj so that the values from the previous model are used as starting values. If FALSE then a call is made to asreml in which the only changes from the previous call are that (i) models are modifed for the supplied terms and (ii) modifications specified via ... are made. |
| set.terms | A character vector specifying the terms that are to have bounds and/or initial values set prior to fitting. |
| ignore.suffices | |
| | A logical vector specifying whether the suffices of the asreml-assigned names of the variance terms (i.e. the information to the right of an "!", other than "R!") is to be ignored in matching elements of terms. If TRUE for an element of terms, the suffices are stripped from the asreml-assigned names. If FALSE for an element of terms, the element must exactly match an asreml-assigned name for a variance term. This vector must be of length one or the same length as terms. If it is of length one then the same action is applied to the asreml-assigned suffices for all the terms in terms. |
| bounds | A character vector specifying the bounds to be applied to the terms specified in set.terms. This vector must be of length one or the same length as set.terms. If it is of length one then the same constraint is applied to all the terms in set.terms. If any of the bounds are equal to NA then they are left unchanged for those terms. |

initial.values  A character vector specifying the initial values for the terms specified in terms. This vector must be of length one or the same length as terms. If it is of length one then the same initial value is applied to all the terms in terms. If any of the initial.values are equal to NA then they are left unchanged for those terms.

...             Further arguments passed to asreml, wald.asreml and as.asrtests.

**Value**

An asrtests.object containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary. If the term is not in the model, then the supplied asreml object will be returned. Also, reml.test will have the likelihood ratio and the p-value set to NA and the degrees of freedom to zero. Similarly, the row of test.summary for the term will have its name, DF set to NA, p-value set to NA, and action set to Absent.

**Author(s)**

Chris Brien

**See Also**

asremlPlus-package, as.asrtests, chooseModel.asrtests, REMLRT.asreml, rmboundary.asrtests, newfit.asreml, reparamSigDevn.asrtests, changeTerms.asrtests

**Examples**

```
## Not run:
data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary(current.asrt)
# Test nugget term
current.asrt <- testranfix(current.asrt, "units", positive=TRUE)

## End(Not run)
```

---

testresidual.asrtests  *Fits a new residual formula, tests whether the change is significant and records the result in an* asrtests.object.

---

**Description**

Fits a new residual formula using asreml-R4 (replaces the rcov formula of asreml-R3) and tests whether the change is significant. If simpler = FALSE the model to be fitted must be more complex than the one whose fit has been stored in asrtests.obj. That is, the new model must have more parameters. However, if simpler = TRUE the model to be fitted must be simpler than the one whose fit has been stored in asrtests.obj in that it must have fewer parameters. Any boundary terms are removed using rmboundary.asrtests, which may mean that the models are not nested. The test is a REML likelihood ratio test that is performed using REMLRT.asreml, which is only valid if the models are nested. It compares the newly fitted model with the fit of the model in asrtest.obj. A row is added to the test.summary data.frame using the supplied label.

## Usage

```
## S3 method for class 'asrtests'
testresidual(asrtests.obj, terms=NULL, label = "R model",
             simpler = FALSE, alpha = 0.05, allow.unconverged = TRUE,
             checkboundaryonly = FALSE, positive.zero = FALSE,
             bound.test.parameters = "none",
             bound.exclusions = c("F","B","S","C"), REMLDF = NULL,
             denDF="numeric", update = TRUE, trace = FALSE,
             set.terms = NULL, ignore.suffices = TRUE,
             bounds = "P", initial.values = NA, ...)
```

## Arguments

| | |
|---|---|
| asrtests.obj | an asrtests.object for a fitted model that is a list containing the componets (i) asreml.obj, (ii) wald.tab (iii) test.summary. |
| terms | A model for the residual argument in asreml-R4 (the rcov formula in older versions of asreml), stored as a character. To remove the model, enter "-(.)". |
| label | A character string to use as the label in test.summary and which indicates what is being tested. |
| simpler | A logical indicating whether the new model to be fitted is simpler than the already fitted model whose fit is stored in asrtests.obj. |
| alpha | The significance level for the test. |
| allow.unconverged | |
| | A logical indicating whether to accept a new model even when it does not converge. If FALSE and the fit of the new model does not converge, the supplied asreml object is returned. Also, if FALSE and the fit of the new model has converged, but that of the old model has not, the new model will be accepted. |
| checkboundaryonly | |
| | If TRUE then boundary and singular terms are not removed by rmboundary.asrtests; a warning is issued instead. |
| positive.zero | Indicates whether the hypothesized values for the variance components being tested are on the boundary of the parameter space. For example, this is true for positively-constrained variance components that, under the reduced model, are zero. This argument does not need to be set if bound.test.parameters is set. |
| bound.test.parameters | |
| | Indicates whether for the variance components being tested, at least some of the hypothesized values are on the boundary of the parameter space. The possibilities are "none", "onlybound" and "one-and-one". The default is "none", although if it is set to "none" and positive.zero is TRUE then bound.test.parameters is taken to be "onlybound". When bound.test.parameters is set to "one-and-one", it signifies that there are two parameters being tested, one of which is bound and the other is not. For example, the latter is true for testing a covariance and a positively-constrained variance component that, under the reduced model, are zero. |
| bound.exclusions | |
| | A character specifying one or more bound (constraint) codes that will result in a variance parameter being excluded from the count of estimated variance parameters in using REMLRT.asreml. If set to NULL then none will be excluded. |
| REMLDF | A numeric giving the difference in the number of variance parameters whose estimates are not of the type specified in bound.exclusions for two models |

being compared in a REML ratio test using [REMLRT.asreml](). If NULL then this
is determined from the information in the asreml object for the two models.

denDF          Specifies the method to use in computing approximate denominator degrees of
               freedom when wald.asreml is called. Can be none to suppress the compu-
               tations, numeric for numerical methods, algebraic for algebraic methods or
               default, the default, to autommatically choose numeric or algebraic compu-
               tations depending on problem size. The denominator degrees of freedom are
               calculated according to Kenward and Roger (1997) for fixed terms in the dense
               part of the model.

update         If TRUE then update.asreml is called to fit the model with the residual (rcov)
               model supplied in terms. In doing this the arguments R.param and G.param are
               set to those in the asreml object stored in asrtests.obj so that the values from
               the previous model are used as starting values. If FALSE then a call is made to
               asreml in which the only changes from the previous call are that (i) residual
               (rcov) model is that specified in terms and (ii) modifications specified via . . .
               are made.

trace          If TRUE then partial iteration details are displayed when ASReml-R functions
               are invoked; if FALSE then no output is displayed.

set.terms      A [character]() vector specifying the terms that are to have bounds and/or initial
               values set prior to fitting.

ignore.suffices

               A [logical]() vector specifying whether the suffices of the asreml-assigned names
               of the variance terms (i.e. the information to the right of an "!", other than "R!")
               is to be ignored in matching elements of terms. If TRUE for an element of
               terms, the suffices are stripped from the asreml-assigned names. If FALSE for
               an element of terms, the element must exactly match an asreml-assigned name
               for a variance term. This vector must be of length one or the same length as
               terms. If it is of length one then the same action is applied to the asreml-
               assigned suffices for all the terms in terms.

bounds         A [character]() vector specifying the bounds to be applied to the terms speci-
               fied in set.terms. This vector must be of length one or the same length as
               set.terms. If it is of length one then the same constraint is applied to all the
               terms in set.terms. If any of the bounds are equal to NA then they are left
               unchanged for those terms.

initial.values A character vector specifying the initial values for the terms specified in terms.
               This vector must be of length one or the same length as terms. If it is of length
               one then the same initial value is applied to all the terms in terms. If any of the
               initial.values are equal to NA then they are left unchanged for those terms.

...            Further arguments passed to asreml, wald.asreml and [as.asrtests]().

## Value

An [asrtests.object]() containing the components (i) asreml.obj, (ii) wald.tab, and (iii) test.summary.
If the term is not in the model, then the supplied asreml.obj will be returned. Also, reml.test
will have the likelihood ratio and the p-value set to NA and the degrees of freedom to zero. Simi-
larly, the row of test.summary for the term will have its name, a p-value set to NA, and action set
to Absent.

## Author(s)

Chris Brien

## See Also

asremlPlus-package, as.asrtests, changeTerms.asrtests,
chooseModel.asrtests, REMLRT.asreml, rmboundary.asrtests,
newfit.asreml, testswapran.asrtests, changeTerms.asrtests,
reparamSigDevn.asrtests

## Examples

```
## Not run:
data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary(current.asrt)
# Test Row autocorrelation
current.asrt <- testresidual(current.asrt, "~ Row:ar1(Column)",
                             label="Row autocorrelation", simpler=TRUE)
print(current.asrt)

## End(Not run)
```

---

| testswapran.asrtests | *Tests, using a REMLRT, the significance of the difference between the current random model and one in which oldterms are dropped and newterms are added. The result is recorded in an* asrtests.object. |
|---|---|

---

## Description

Fits a new random model using asreml by removing oldterms and adding newterms. If simpler = FALSE the model to be fitted must be more complex than the one whose fit has been stored in asrtests.obj. That is, the new model must have more parameters. However, if simpler = TRUE the model to be fitted must be simpler than the one whose fit has been stored in asrtests.obj in that it must have fewer parameters. The test is a REML ratio test that is performed using REMLRT.asreml, which is only valid if the models are nested. It compares the newly fitted model with the fit of the model in asrtest.obj. A row is added to the test.summary data.frame using the supplied label. If the newly fitted model is retained, any boundary terms are then removed using rmboundary.asrtests.

## Usage

```
## S3 method for class 'asrtests'
testswapran(asrtests.obj, oldterms = NULL, newterms = NULL,
            label = "Swap in random model", simpler = FALSE,
            alpha = 0.05, allow.unconverged = TRUE, checkboundaryonly = FALSE,
            positive.zero = FALSE, bound.test.parameters = "none",
            bound.exclusions = c("F","B","S","C"), REMLDF = NULL,
            denDF="numeric", trace = FALSE, update = TRUE,
            set.terms = NULL, ignore.suffices = TRUE,
            bounds = "P", initial.values = NA, ...)
```

**Arguments**

| | |
|---|---|
| asrtests.obj | an [asrtests.object](#) for a fitted model that is a list containing the componets (i) asreml.obj, (ii) wald.tab (iii) test.summary. |
| oldterms | Terms, stored as a character, that are to be removed from the random model using asreml. |
| newterms | Terms, stored as a character, that are to be added to the random model using asreml. |
| simpler | A logical indicating whether the new model to be fitted. after the changes made as a result of swapping oldterms for newterms, is simpler than the already fitted model whose fit is stored in asrtests.obj. |
| alpha | The significance level for the test. |
| allow.unconverged | |
| | A logical indicating whether to accept a new model even when it does not converge. If FALSE and the fit of the new model does not converge, the supplied asreml object is returned. Also, if FALSE and the fit of the new model has converged, but that of the old model has not, the new model will be accepted. |
| checkboundaryonly | |
| | If TRUE then boundary and singular terms are not removed by [rmboundary.asrtests](#); a warning is issued instead. |
| label | A character string to use as the label in test.summary and which indicates what is being tested. |
| positive.zero | Indicates whether the hypothesized values for the variance components being tested are on the boundary of the parameter space. For example, this is true for positively-constrained variance components that, under the reduced model, are zero. This argument does not need to be set if bound.test.parameters is set. |
| bound.test.parameters | |
| | Indicates whether for the variance components being tested, at least some of the hypothesized values are on the boundary of the parameter space. The possibilities are "none", "onlybound" and "one-and-one". The default is "none", although if it is set to "none" and positive.zero is TRUE then bound.test.parameters is taken to be "onlybound". When bound.test.parameters is set to "one-and-one", it signifies that there are two parameters being tested, one of which is bound and the other is not. For example, the latter is true for testing a covariance and a positively-constrained variance component that, under the reduced model, are zero. |
| bound.exclusions | |
| | A character specifying one or more bound (constraint) codes that will result in a variance parameter being excluded from the count of estimated variance parameters in using [REMLRT.asreml](#). If set to NULL then none will be excluded. |
| REMLDF | A numeric giving the difference in the number of variance parameters whose estimates are not of the type specified in bound.exclusions for two models being compared in a REML ratio test using [REMLRT.asreml](#). If NULL then this is determined from the information in the asreml object for the two models. |
| denDF | Specifies the enthod to use in computing approximate denominator degrees of freedom when wald.asreml is called. Can be none to suppress the computations, numeric for numerical methods, algebraic for algebraic methods or default, the default, to autommatically choose numeric or algebraic computations depending on problem size. The denominator degrees of freedom are calculated according to Kenward and Roger (1997) for fixed terms in the dense part of the model. |

| | |
|---|---|
| trace | If TRUE then partial iteration details are displayed when ASReml-R functions are invoked; if FALSE then no output is displayed. |
| update | If TRUE then update.asreml is called to change the model. In doing this the arguments R.param and G.param are set to those in the asreml object stored in asrtests.obj so that the values from the previous model are used as starting values. If FALSE then a call is made to asreml in which the only changes from the previous call are that (i) models are modifed for the supplied oldterms and newterms, and (ii) modifications specified via ... are made. |
| set.terms | A character vector specifying the terms that are to have bounds and/or initial values set prior to fitting. |
| ignore.suffices | |
| | A logical vector specifying whether the suffices of the asreml-assigned names of the variance terms (i.e. the information to the right of an "!", other than "R!") is to be ignored in matching elements of terms. If TRUE for an element of terms, the suffices are stripped from the asreml-assigned names. If FALSE for an element of terms, the element must exactly match an asreml-assigned name for a variance term. This vector must be of length one or the same length as terms. If it is of length one then the same action is applied to the asreml-assigned suffices for all the terms in terms. |
| bounds | A [character](character) vector specifying the bounds to be applied to the terms specified in set.terms. This vector must be of length one or the same length as set.terms. If it is of length one then the same constraint is applied to all the terms in set.terms. If any of the bounds are equal to NA then they are left unchanged for those terms. |
| initial.values | A character vector specifying the initial values for the terms specified in terms. This vector must be of length one or the same length as terms. If it is of length one then the same initial value is applied to all the terms in terms. If any of the initial.values are equal to NA then they are left unchanged for those terms. |
| ... | Further arguments passed to asreml, wald.asreml and [as.asrtests](as.asrtests). |

## Value

An [asrtests.object](asrtests.object) for a fitted model that is a list containing the componets (i) asreml.obj, (ii) wald.tab (iii) test.summary. If the term is not in the model, then the supplied asreml object will be returned. Also, reml.test will have the likelihood ratio and the p-value set to NA and the degrees of freedom to zero. Similarly, the row of test.summary for the term will have its name, a p-value set to NA, and action set to Absent.

## Author(s)

Chris Brien

## See Also

[as.asrtests](as.asrtests), [chooseModel.asrtests](chooseModel.asrtests), [REMLRT.asreml](REMLRT.asreml), [rmboundary.asrtests](rmboundary.asrtests),
[newfit.asreml](newfit.asreml), [testresidual.asrtests](testresidual.asrtests), [changeTerms.asrtests](changeTerms.asrtests), [reparamSigDevn.asrtests](reparamSigDevn.asrtests)

## Examples

```
## Not run:
current.asrt <- testswapran(current.asrt, oldterms = "str(~ Cart/xDays, ~us(2):id(184))",
                            newterms = "Cart/xDays", pos = FALSE,
```

```
                                     label = "Intercept/Slope correlation",
                                     simpler = TRUE)
  print(current.asrt)

## End(Not run)
```

---

validAlldiffs          *Checks that an object is a valid alldiffs object.*

---

### Description

Checks that an `object` is an `alldiffs.object` of S3-class alldiffs containing the components `asreml.obj`, `wald.tab` and `test.summary`.

### Usage

```
validAlldiffs(object)
```

### Arguments

object          an `alldiffs.object`.

### Value

TRUE or a character describing why the object is not a valid `alldiffs.object`.

### Author(s)

Chris Brien

### See Also

`alldiffs.object`, `is.alldiffs`, `as.alldiffs`, `validPredictionsFrame`, `validAsrtests`

### Examples

```
    data(Oats.dat)

    ## Use lmerTest and emmmeans to get predictions and associated statistics
    if (requireNamespace("lmerTest", quietly = TRUE) &
        requireNamespace("emmeans", quietly = TRUE))
    {
      m1.lmer <- lmerTest::lmer(Yield ~ Nitrogen*Variety + (1|Blocks/Wplots),
                                data=Oats.dat)
      Var.emm <- emmeans::emmeans(m1.lmer, specs = ~ Nitrogen:Variety)
      Var.preds <- summary(Var.emm)
      den.df <- min(Var.preds$df)
      ## Modify Var.preds to be compatible with a predictions.frame
      Var.preds <- as.predictions.frame(Var.preds, predictions = "emmean",
                                        se = "SE", interval.type = "CI",
                                        interval.names = c("lower.CL", "upper.CL"))
      Var.vcov <- vcov(Var.emm)
      Var.sed <- NULL
```

```
    ## Form an all.diffs object
     Var.diffs <- as.alldiffs(predictions = Var.preds, classify = "Nitrogen:Variety",
                                 sed = Var.sed, vcov = Var.vcov, tdf = den.df)

    ## check the validity of Var.diffs
    validAlldiffs(Var.diffs)
  }
```

---

validAsrtests          *Checks that an object is a valid asrtests object.*

---

### Description

Checks that an object is an asrtests.object of S3-class asrtests containing the components asreml.obj, wald.tab and test.summary.

### Usage

```
validAsrtests(object)
```

### Arguments

object             an asrtests.object.

### Value

TRUE or a character describing why the object is not a valid asrtests.object.

### Author(s)

Chris Brien

### See Also

asrtests.object, is.asrtests, as.asrtests,
validPredictionsFrame, validAlldiffs

### Examples

```
## Not run:
library(dae)
library(asreml)
library(asremlPlus)
## use ?Wheat.dat for data set details
data(Wheat.dat)

# Fit initial model
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
                      data=Wheat.dat)

# Load current fit into an asrtests object
```

```
current.asrt <- as.asrtests(current.asr, NULL, NULL)

# check validity of current.asrt
validAsrtests(current.asrt)

## End(Not run)
```

---

validPredictionsFrame    *Checks that an object is a valid predictions.frame.*

---

### Description

Checks that an `object` is a `predictions.frame` of S3-class `data.frame` that contains the columns predicted.value, standard.error and est.status.

### Usage

```
validPredictionsFrame(object)
```

### Arguments

object            an `predictions.frame`.

### Value

`TRUE` or a `character` describing why the `object` is not a valid `predictions.frame`.

### Author(s)

Chris Brien

### See Also

`predictions.frame`, `validAsrtests`, `validAlldiffs`

### Examples

```
data(Oats.dat)

## Use asreml to get predictions and associated statistics

## Not run:
m1.asr <- asreml(Yield ~ Nitrogen*Variety,
                 random=~Blocks/Wplots,
                 data=Oats.dat)
current.asrt <- as.asrtests(m1.asr)
Var.pred <- asreml::predict.asreml(m1.asr, classify="Nitrogen:Variety",
                                   sed=TRUE)
if (getASRemlVersionLoaded(nchar = 1) == "3")
  Var.pred <- Var.pred$predictions
Var.preds <- as.predictions.frame(Var.pred$pvals, se = "std.error",
                                  est.status = "status")
```

```
## End(Not run)

  ## Use lmerTest and emmmeans to get predictions and associated statistics
  if (requireNamespace("lmerTest", quietly = TRUE) &
      requireNamespace("emmeans", quietly = TRUE))
  {
    m1.lmer <- lmerTest::lmer(Yield ~ Nitrogen*Variety + (1|Blocks/Wplots),
                              data=Oats.dat)
    Var.emm <- emmeans::emmeans(m1.lmer, specs = ~ Nitrogen:Variety)
    Var.preds <- summary(Var.emm)
    Var.preds <- as.predictions.frame(Var.preds, predictions = "emmean",
                                      se = "SE", interval.type = "CI",
                                      interval.names = c("lower.CL", "upper.CL"))
  }

  if (exists("Var.preds"))
  {
    ## Check the class and validity of the predictions.frame
    is.predictions.frame(Var.preds)
    validPredictionsFrame(Var.preds)
  }
```

---

variofaces.asreml          *Plots empirical variogram faces, including envelopes, as described by*
                           *Stefanova, Smith & Cullis (2009).*

---

### Description

A function that produces a plot for each face of an empirical 2D variogram based on residuals produced after the fitting of a model using the function asreml. It also adds envelopes to the plot by simulating data sets in parallel from a multivariate normal distribution with expectation equal to the fitted values obtained from the fixed and spline terms and variance matrix equal to the fitted variance matrix (Stefanova, Smith & Cullis, 2009). The plot is constrolled by the residual model, which must consist of two factors corresponding to the two physical dimensions underlying the data. It can also have a third term involving the at or dsum function that defines sections of the data, such as experiments in different environments. In this case, the two variogram faces are produced for each section.

### Usage

```
## S3 method for class 'asreml'
variofaces(asreml.obj, means=NULL, V=NULL, nsim=100, seed = NULL,
           extra.matrix = NULL, ignore.terms = NULL, fixed.spline.terms = NULL,
           bound.exclusions = c("F","B","S","C"), tolerance=1E-10,
           units = "ignore", update = TRUE, trace = FALSE,
           graphics.device=NULL, ncores = detectCores(), ...)
```

### Arguments

asreml.obj          An asreml object from a call to asreml in which the data argument has been
                    set.

means          The vector of means to be used in generating simulated data sets. If it is NULL,
               the fitted values based on object are used. It must be the same length as the
               response variable for object.

V              The fitted variance matrix, i.e. having the appropriate pattern and values given
               the model fitted to the observed data and the estimates of the parameters ob-
               tained. If V is NULL then estimateV.asreml is called to obtain it from asreml.obj

nsim           The number of data sets to be simulated in obtaining the envelopes.

seed           A single value, interpreted as an integer, that specifies the starting value of the
               random number generator. The "L'Ecuyer-CMRG" random generator is used
               and nextRNGStream is used to seed each core from the original seed.

extra.matrix   A matrix of order equal to the number of observations that is to be added to
               the varaince matrix, the latter based on the information in asreml.obj. It is
               assumed that the sigma-parameterized values of the variance parameter esti-
               mates, such as is given in the varcomp component of summary.asreml, have
               been used in calculating extra.matrix; the values in the vparameters compo-
               nent of G.param and R.param may be either gamma- or sigma-parameterized.
               The argument extra.matrix can be used in conjunction with ignore.terms as
               a workaround to include components of the variance matrix for variance func-
               tions that have not been implemented in estimateV.

ignore.terms   A character giving terms from either the random or residual models that are
               to be ignored in that their contributions to the variance is not to be included in the
               estimated matrix. The term names are those given in the vparameters compo-
               nent of the asreml object or the varcomp component produced by summary.asreml,
               but only up to the first exclamation mark (!). This can be used in conjunction
               with estimateV.asreml as a workaround to include components of the variance
               matrix for variance functions that have not been implemented in estimateV.

fixed.spline.terms
               A character vector giving one or mor spline terms in the random model that are
               regarded as fixed and so are to be ignored because they are not regarded as con-
               tributing to the variance. The term names are those given in the vparameters
               component of the asreml object or the varcomp component produced by summary.asreml,
               but only up to the first exclamation mark (!).

bound.exclusions
               A character specifying one or more bound codes that will result in a variance
               parameter in the random model being excluded from contributing to the vari-
               ance. If set to NULL then none will be excluded.

tolerance      The value such that eigenvalues less than it are considered to be zero.

units          A character indicating whether the BLUPs for units are added to the residuals
               when this reserved factor is included in the random model. Possible values are
               addtoresiduals and ignore. If standardized conditional residuals are plotted
               and the BLUPs for units are to be added then it is the standardized BLUPs that
               are added.

update         If TRUE then the arguments R.param and G.param are set to those in the asreml
               object supplied in object so that the values from the original model are used
               as starting values. If FALSE then calls are made to asreml in which the only
               changes from the previous call are (i) the model is fitted to simulated data and
               (ii) modifications specified via ... are made, except that changes cannot be
               made to any of the models.

trace          If TRUE then partial iteration details are displayed when ASReml-R functions
               are invoked; if FALSE then no output is displayed.

graphics.device

> A character specifying a graphics device for plotting. The default is
> graphics.device = NULL, which will result in plots being produced on the current graphics device. Setting it to "windows", for example, will result in a windows graphics device being opened.

ncores      A numeric specifying the number of cores to use in doing the simulations.

...         Other arguments that are passed down to the function asreml. Changes to the
            models are not allowed. Other changes are dangerous and generally should be
            avoided.

### Details

The residual model is scanned to ensure that it involves only two factors not included in the at function, and to see if it has a third factor in an at function. If so, the faces of the 2D variogram, each based on one of the two non-at factors, are derived from the residuals in the supplied asreml object using asreml.variogram, this yielding the observed variogram faces. If aom was set to TRUE for the asreml object, the standardized consitional residuals are used. Then nsim data sets are generated by adding the fitted.values, extracted from the asreml object, to a vector of values randomly generated from a normal distribution with expectation zero and variance matrix V. Each data set is analyzed using the model in object and several sets are generated and analyzed in parallel. The variogram values for the faces are obtained using asreml.variogram stored. Note, if the analysis for a data set does not converge in maxiter iterations, it is discarded and a replacement data set generated. The value of maxiter can be specified in the call to variofaces.asreml. Plots are produced for each face and include the observed values and the 2.5%, 50% & 97.5% quantiles.

### Value

A list with the following components:

1. **face1:** a data.frame containing the variogram values on which the plot for the first dimension is based.

2. **face2:** a data.frame containing the variogram values on which the plot for the second dimension is based.

### Author(s)

Chris Brien

### References

Stefanova, K. T., Smith, A. B. & Cullis, B. R. (2009) Enhanced diagnostics for the spatial analysis of field trials. *Journal of Agricultural, Biological, and Environmental Statistics*, **14**, 392–410.

### See Also

[asremlPlus-package](), asreml, [plotVariofaces.data.frame](), [simulate.asreml](), [set.seed]().

### Examples

```
## Not run:
data(Wheat.dat)
current.asr <- asreml(yield ~ Rep + WithinColPairs + Variety,
                      random = ~ Row + Column + units,
                      residual = ~ ar1(Row):ar1(Column),
```

```
                           data=Wheat.dat)
current.asrt <- as.asrtests(current.asr, NULL, NULL)
current.asrt <- rmboundary.asrtests(current.asrt)
# Form variance matrix based on estimated variance parameters
s2 <- current.asr$sigma2
gamma.Row <- current.asr$gammas[1]
gamma.unit <- current.asr$gammas[2]
rho.r <- current.asr$gammas[4]
rho.c <- current.asr$gammas[5]
row.ar1 <- mat.ar1(order=10, rho=rho.r)
col.ar1 <- mat.ar1(order=15, rho=rho.c)
V <- gamma.Row * fac.sumop(Wheat.dat$Row) +
     gamma.unit * diag(1, nrow=150, ncol=150) +
     mat.dirprod(col.ar1, row.ar1)
V <- s2*V

#Produce variogram faces plot (Stefanaova et al, 2009)
variofaces(current.asr, V=V, ncores = 2)

## End(Not run)
```

---

| WaterRunoff.dat | *Data for an experiment to investigate the quality of water runoff over time* |
|---|---|

---

### Description

This data is from an experiment to investigate the quality of water runoff. However, it has been modified to hide the true identity of the Species and Sources. It is used to provide executable examples of the functions listed under **Examples**.

### Usage

```
data(WaterRunoff.dat)
```

### Format

A data.frame containing 440 observations of 13 variables.

### Author(s)

Chris Brien

### Source

Kazemi, F. (pers. comm.)

### See Also

chooseModel.asrtests, reparamSigDevn.asrtests,
plotPredictions.data.frame, predictPlus.asreml, predictPresent.asreml

---

Wheat.dat       *Data for an experiment to investigate 25 varieties of wheat*

---

### Description

The data appears in Gilmour et al. [1995] and is from a field experiment designed to compare the performance of 25 varieties of wheat. An analysis of it using asreml is presented by Butler et al. (2018, Section 7.6), although they suggest that it is a barley experiment. It is used in `asremlPlus-package` as an executable example of the use of the `asremlPlus` to analyse a data set.

The experiment was conducted at Slate Hall Farm, UK, in 1976 and was designed as a balanced lattice square with 6 replicates laid out in a $10 \times 15$ rectangular grid. The columns in the data frame are: Rep, Row, Column, WithinColPairs, Variety, yield. The response variable is the grain yield.

### Usage

```
data(Wheat.dat)
```

### Format

A data.frame containing 150 observations of 6 variables.

### Author(s)

Chris Brien

### Source

Butler, D. G., Cullis, B. R., Gilmour, A. R., Gogel, B. J. and Thompson, R. (2018). *ASReml-R Reference Manual Version 4.* VSN International Ltd, http://asreml.org.

Gilmour, A. R., et al. (1995) Average Information REML: An efficient algorithm for variance parameter estimation in linear mixed models. *Biometrics*, **51**, 1440-1450.

# Index