Package 'multid'

June 8, 2022

Title Multivariate Difference Between Two Groups

Version 0.6.0

Description Estimation of multivariate differences between two groups (e.g., multivariate sex differences) with regularized regression methods and predictive approach. See Lönnqvist & Ilmarinen (2021) <doi:10.1007/s11109-021-09681-2> and Ilmarinen et al. (2022) <doi:10.1177/08902070221088155>.
Includes tools that help in understanding difference score reliability, predictions of difference score variables, conditional intra-class correlations, and heterogeneity of variance estimates. Package development was supported by the Academy of Finland research grant 338891.

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Encoding UTF-8

BugReports https://github.com/vjilmari/multid/issues

RoxygenNote 7.1.2

Imports dplyr (>= 1.0.7), glmnet (>= 4.1.2), stats (>= 4.0.2), pROC (>= 1.18.0), lavaan (>= 0.6.9), emmeans (>= 1.6.3), lme4 (>= 1.1.27.1)

Suggests knitr, rmarkdown, overlapping (>= 1.7), rio (>= 0.5.29)

VignetteBuilder knitr

NeedsCompilation no

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Repository CRAN

Date/Publication 2022-06-08 14:40:02 UTC

R topics documented:

`colwise_pool` *Column-wise pooling of standard deviations*

Description

Column-wise pooling of standard deviations

Usage

```
colwise_pool(data, n1, n2, m1, m2, sd1, sd2)
```

Arguments

`data`	Data frame of d_pooled_sd output for multiple samples.
`n1`	Sample sizes of group1.
`n2`	Sample sizes of group2.
`m1`	Means of group1.
`m2`	Means of group2.
`sd1`	Standard deviations of group1.
`sd2`	Standard deviations of group2.

Value

pooled SDs for groups and across groups

cvv *Coefficient of variance variation*

Description

Calculates three different indices for variation between two or more variance estimates. VR = Variance ratio between the largest and the smallest variance. CVV = Coefficient of variance variation (Box, 1954). SVH = Standardized variance heterogeneity (Ruscio & Roche, 2012).

Usage

```
cvv(data)
```

Arguments

data	Data frame of two or more columns or list of two or more variables.

Value

A vector including VR, CVV, and SVH.

References

Box, G. E. P. (1954). Some Theorems on Quadratic Forms Applied in the Study of Analysis of Variance Problems, I. Effect of Inequality of Variance in the One-Way Classification. The Annals of Mathematical Statistics, 25(2), 290–302.

Ruscio, J., & Roche, B. (2012). Variance Heterogeneity in Published Psychological Research: A Review and a New Index. Methodology, 8(1), 1–11. https://doi.org/10.1027/1614-2241/a000034

Examples

```
d <- list(
  X1 = rnorm(10, sd = 10),
  X2 = rnorm(100, sd = 7.34),
  X3 = rnorm(1000, sd = 6.02),
  X4 = rnorm(100, sd = 5.17),
  X5 = rnorm(10, sd = 4.56)
)
cvv(d)
```

cvv_manual *Coefficient of variance variation from manual input sample sizes and variance estimates*

Description

Calculates three different indices for variation between two or more variance estimates. VR = Variance ratio between the largest and the smallest variance. CVV = Coefficient of variance variation (Box, 1954). SVH = Standardized variance heterogeneity (Ruscio & Roche, 2012).

Usage

```
cvv_manual(sample_sizes, variances)
```

Arguments

sample_sizes	Numeric vector of length > 1. Sample sizes used for each variance estimate.
variances	Numeric vector of length > 1. Variance estimates.

Value

A vector including VR, CVV, and SVH.

References

Box, G. E. P. (1954). Some Theorems on Quadratic Forms Applied in the Study of Analysis of Variance Problems, I. Effect of Inequality of Variance in the One-Way Classification. The Annals of Mathematical Statistics, 25(2), 290–302.

Ruscio, J., & Roche, B. (2012). Variance Heterogeneity in Published Psychological Research: A Review and a New Index. Methodology, 8(1), 1–11. https://doi.org/10.1027/1614-2241/a000034

Examples

```
cvv_manual(sample_sizes=c(10,100,1000,75,3),
variances=c(1.5,2,2.5,3,3.5))
```

d_pooled_sd *Standardized mean difference with pooled standard deviation*

Description

Standardized mean difference with pooled standard deviation

Usage

```
d_pooled_sd(
  data,
  var,
  group.var,
  group.values,
  rename.output = TRUE,
  infer = FALSE
)
```

Arguments

data	A data frame.
var	A continuous variable for which difference is estimated.
group.var	The name of the group variable.
group.values	Vector of length 2, group values (e.g. c("male", "female) or c(0,1)).
rename.output	Logical. Should the output values be renamed according to the group.values? Default TRUE.
infer	Logical. Statistical inference with Welch test? (default FALSE)

Value

Descriptive statistics and mean differences

Examples

```
d_pooled_sd(iris[iris$Species == "setosa" | iris$Species == "versicolor", ],
  var = "Petal.Length", group.var = "Species",
  group.values = c("setosa", "versicolor"), infer = TRUE
)
```

D_regularized *Multivariate group difference estimation with regularized binomial regression*

Description

Multivariate group difference estimation with regularized binomial regression

Usage

```
D_regularized(
  data,
  mv.vars,
  group.var,
  group.values,
```

```
  alpha = 0.5,
  nfolds = 10,
  s = "lambda.min",
  type.measure = "deviance",
  rename.output = TRUE,
  out = FALSE,
  size = NULL,
  fold = FALSE,
  fold.var = NULL,
  pcc = FALSE,
  auc = FALSE,
  pred.prob = FALSE,
  prob.cutoffs = seq(0, 1, 0.2),
  append.data = FALSE
)
```

Arguments

data	A data frame.
mv.vars	Character vector. Variable names in the multivariate variable set.
group.var	The name of the group variable.
group.values	Vector of length 2, group values (e.g. c("male", "female) or c(0,1)).
alpha	Alpha-value for penalizing function ranging from 0 to 1: 0 = ridge regression, 1 = lasso, 0.5 = elastic net (default).
nfolds	Number of folds used for obtaining lambda (range from 3 to n-1, default 10).
s	Which lambda value is used for predicted values? Either "lambda.min" (default) or "lambda.1se".
type.measure	Which measure is used during cross-validation. Default "deviance".
rename.output	Logical. Should the output values be renamed according to the group.values? Default TRUE.
out	Logical. Should results and predictions be calculated on out-of-bad data set? (Default FALSE)
size	Integer. Number of cases in regularization data per each group. Default 1/4 of cases.
fold	Logical. Is regularization applied across sample folds with separate predictions for each fold? (Default FALSE)
fold.var	Character string. Name of the fold variable. (default NULL)
pcc	Logical. Include probabilities of correct classification? Default FALSE.
auc	Logical. Include area under the receiver operating characteristics? Default FALSE.
pred.prob	Logical. Include table of predicted probabilities? Default FALSE.
prob.cutoffs	Vector. Cutoffs for table of predicted probabilities. Default seq(0,1,0.20).
append.data	Logical. If TRUE, the data is appended to the predicted variables.

Value

D	Multivariate descriptive statistics and differences.
pred.dat	A data.frame with predicted values.
cv.mod	Regularized regression model from cv.glmnet.
P.table	Table of predicted probabilities by cutoffs.

References

Lönnqvist, J. E., & Ilmarinen, V. J. (2021). Using a continuous measure of genderedness to assess sex differences in the attitudes of the political elite. Political Behavior, 43, 1779–1800. https://doi.org/10.1007/s11109-021-09681-2

Ilmarinen, V. J., Vainikainen, M. P., & Lönnqvist, J. E. (2022). Is there a g-factor of genderedness? Using a continuous measure of genderedness to assess sex differences in personality, values, cognitive ability, school grades, and educational track. European Journal of Personality. https://doi.org/10.1177/089020702210881

See Also

cv.glmnet

Examples

```
D_regularized(
  data = iris[iris$Species == "setosa" | iris$Species == "versicolor", ],
  mv.vars = c("Sepal.Length", "Sepal.Width", "Petal.Length", "Petal.Width"),
  group.var = "Species", group.values = c("setosa", "versicolor")
)$D

# out-of-bag predictions
D_regularized(
  data = iris[iris$Species == "setosa" | iris$Species == "versicolor", ],
  mv.vars = c("Sepal.Length", "Sepal.Width", "Petal.Length", "Petal.Width"),
  group.var = "Species", group.values = c("setosa", "versicolor"),
  out = TRUE, size = 15, pcc = TRUE, auc = TRUE
)$D

# separate sample folds
# generate data for 10 groups
set.seed(34246)
n1 <- 100
n2 <- 10
d <-
  data.frame(
    sex = sample(c("male", "female"), n1 * n2, replace = TRUE),
    fold = sample(x = LETTERS[1:n2], size = n1 * n2, replace = TRUE),
    x1 = rnorm(n1 * n2),
    x2 = rnorm(n1 * n2),
    x3 = rnorm(n1 * n2)
  )

# Fit and predict with same data
```

```
D_regularized(
  data = d,
  mv.vars = c("x1", "x2", "x3"),
  group.var = "sex",
  group.values = c("female", "male"),
  fold.var = "fold",
  fold = TRUE,
  rename.output = TRUE
)$D

# Out-of-bag data for each fold
D_regularized(
  data = d,
  mv.vars = c("x1", "x2", "x3"),
  group.var = "sex",
  group.values = c("female", "male"),
  fold.var = "fold",
  size = 17,
  out = TRUE,
  fold = TRUE,
  rename.output = TRUE
)$D
```

`D_regularized_fold` *Use manually defined data folds for regularization and obtain estimates for each separately.*

Description

Use manually defined data folds for regularization and obtain estimates for each separately.

Usage

```
D_regularized_fold(
  data,
  mv.vars,
  group.var,
  group.values,
  alpha = 0.5,
  s = "lambda.min",
  type.measure = "deviance",
  rename.output = TRUE,
  fold.var,
  append.data = FALSE
)
```

Arguments

data	A data frame.
mv.vars	Character vector. Variable names in the multivariate variable set.
group.var	The name of the group variable.
group.values	Vector of length 2, group values (e.g. c("male", "female) or c(0,1)).
alpha	Alpha-value for penalizing function ranging from 0 to 1: 0 = ridge regression, 1 = lasso, 0.5 = elastic net (default).
s	Which lambda value is used for predicted values? Either "lambda.min" (default) or "lambda.1se".
type.measure	Which measure is used during cross-validation. Default "deviance".
rename.output	Logical. Should the output values be renamed according to the group.values? Default TRUE.
fold.var	Character string. Name of the fold variable.
append.data	Logical. If TRUE, the original data is appended to the predicted variables.

Value

D	Multivariate descriptive statistics and differences.
pred.dat	A data.frame with predicted values.
cv.mod	Regularized regression model from cv.glmnet.

See Also

cv.glmnet

Examples

```
set.seed(34246)
n1 <- 100
n2 <- 10
d <-
  data.frame(
    sex = sample(c("male", "female"), n1 * n2, replace = TRUE),
    fold = sample(x = LETTERS[1:n2], size = n1 * n2, replace = TRUE),
    x1 = rnorm(n1 * n2),
    x2 = rnorm(n1 * n2),
    x3 = rnorm(n1 * n2)
  )

D_regularized_fold(
  data = d,
  mv.vars = c("x1", "x2", "x3"),
  group.var = "sex",
  group.values = c("female", "male"),
  fold.var = "fold"
)$D
```

`D_regularized_fold_out` *Use separate data partitions for regularization and estimation across defined data folds.*

Description

Use separate data partitions for regularization and estimation across defined data folds.

Usage

```
D_regularized_fold_out(
  data,
  mv.vars,
  group.var,
  group.values,
  alpha = 0.5,
  s = "lambda.min",
  type.measure = "deviance",
  rename.output = TRUE,
  size = NULL,
  fold.var,
  pcc = FALSE,
  auc = FALSE,
  pred.prob = FALSE,
  prob.cutoffs = seq(from = 0, to = 1, by = 0.2),
  append.data = FALSE
)
```

Arguments

`data`	A data frame.
`mv.vars`	Character vector. Variable names in the multivariate variable set.
`group.var`	The name of the group variable.
`group.values`	Vector of length 2, group values (e.g. c("male", "female) or c(0,1)).
`alpha`	Alpha-value for penalizing function ranging from 0 to 1: 0 = ridge regression, 1 = lasso, 0.5 = elastic net (default).
`s`	Which lambda value is used for predicted values? Either "lambda.min" (default) or "lambda.1se".
`type.measure`	Which measure is used during cross-validation. Default "deviance".
`rename.output`	Logical. Should the output values be renamed according to the group.values? Default TRUE.
`size`	Integer. Size of regularization data per each group. Default 1/4 of cases.
`fold.var`	Name of the fold variable.

pcc	Logical. Include probabilities of correct classification? Default FALSE.
auc	Logical. Include area under the receiver operating characteristics? Default FALSE.
pred.prob	Logical. Include table of predicted probabilities? Default FALSE.
prob.cutoffs	Vector. Cutoffs for table of predicted probabilities. Default seq(0,1,0.20).
append.data	Logical. If TRUE, the testing data split is appended to the predicted variables.

Value

D	Multivariate descriptive statistics and differences.
pred.dat	A data.frame with predicted values.
cv.mod	Regularized regression model from cv.glmnet.
P.table	Table of predicted probabilities by cutoffs.

Examples

```
set.seed(34246)
n1 <- 100
n2 <- 10
d <-
  data.frame(
    sex = sample(c("male", "female"), n1 * n2, replace = TRUE),
    fold = sample(x = LETTERS[1:n2], size = n1 * n2, replace = TRUE),
    x1 = rnorm(n1 * n2),
    x2 = rnorm(n1 * n2),
    x3 = rnorm(n1 * n2)
  )
D_regularized_fold_out(
  data = d,
  mv.vars = c("x1", "x2", "x3"),
  group.var = "sex",
  group.values = c("female", "male"),
  fold.var = "fold",
  size = 17,
  pcc = TRUE
)$D
```

D_regularized_out *Use separate data partition for regularization and estimation.*

Description

Use separate data partition for regularization and estimation.

Usage

```
D_regularized_out(
  data,
  mv.vars,
  group.var,
  group.values,
  alpha = 0.5,
  nfolds = 10,
  s = "lambda.min",
  type.measure = "deviance",
  rename.output = TRUE,
  size = NULL,
  pcc = FALSE,
  auc = FALSE,
  pred.prob = FALSE,
  prob.cutoffs = seq(from = 0, to = 1, by = 0.2),
  append.data = FALSE
)
```

Arguments

data	A data frame.
mv.vars	Character vector. Variable names in the multivariate variable set.
group.var	The name of the group variable.
group.values	Vector of length 2, group values (e.g. c("male", "female) or c(0,1)).
alpha	Alpha-value for penalizing function ranging from 0 to 1: 0 = ridge regression, 1 = lasso, 0.5 = elastic net (default).
nfolds	Number of folds used for obtaining lambda (range from 3 to n-1, default 10).
s	Which lambda value is used for predicted values? Either "lambda.min" (default) or "lambda.1se".
type.measure	Which measure is used during cross-validation. Default "deviance".
rename.output	Logical. Should the output values be renamed according to the group.values? Default TRUE.
size	Integer. Size of regularization data per each group. Default 1/4 of cases.
pcc	Logical. Include probabilities of correct classification? Default FALSE.
auc	Logical. Include area under the receiver operating characteristics? Default FALSE.
pred.prob	Logical. Include table of predicted probabilities? Default FALSE.
prob.cutoffs	Vector. Cutoffs for table of predicted probabilities. Default seq(0,1,0.20).
append.data	Logical. If TRUE, the testing data split is appended to the predicted variables.

Value

D	Multivariate descriptive statistics and differences.
pred.dat	A data.frame with predicted values.
cv.mod	Regularized regression model from cv.glmnet.
P.table	Table of predicted probabilities by cutoffs.

Examples

```
D_regularized_out(
  data = iris[iris$Species == "setosa" |
    iris$Species == "versicolor", ],
  mv.vars = c(
    "Sepal.Length", "Sepal.Width",
    "Petal.Length", "Petal.Width"
  ),
  group.var = "Species",
  group.values = c("setosa", "versicolor"),
  size = 40,
  pcc = TRUE
)$D
```

D_regularized_vanilla *Use same data partition for regularization and estimation.*

Description

Use same data partition for regularization and estimation.

Usage

```
D_regularized_vanilla(
  data,
  mv.vars,
  group.var,
  group.values,
  alpha = 0.5,
  nfolds = 10,
  s = "lambda.min",
  type.measure = "deviance",
  rename.output = TRUE,
  append.data = FALSE
)
```

Arguments

data	A data frame.
mv.vars	Character vector. Variable names in the multivariate variable set.
group.var	The name of the group variable.
group.values	Vector of length 2, group values (e.g. c("male", "female) or c(0,1)).
alpha	Alpha-value for penalizing function ranging from 0 to 1: 0 = ridge regression, 1 = lasso, 0.5 = elastic net (default).
nfolds	Number of folds used for obtaining lambda (range from 3 to n-1, default 10).
s	Which lambda value is used for predicted values? Either "lambda.min" (default) or "lambda.1se".
type.measure	Which measure is used during cross-validation. Default "deviance".
rename.output	Logical. Should the output values be renamed according to the group.values? Default TRUE.
append.data	Logical. If TRUE, the original data is appended to the predicted variables.

Value

D	Multivariate descriptive statistics and differences.
pred.dat	A data.frame with predicted values.
cv.mod	Regularized regression model from cv.glmnet.

See Also

cv.glmnet

Examples

```
D_regularized(
  data = iris[iris$Species == "setosa" | iris$Species == "versicolor", ],
  mv.vars = c("Sepal.Length", "Sepal.Width", "Petal.Length", "Petal.Width"),
  group.var = "Species", group.values = c("setosa", "versicolor")
)$D
```

---

ml_dadas *Predicting algebraic difference scores in multilevel model*

Description

Decomposes difference score predictions to predictions of difference score components by probing simple effects at the levels of the binary moderator.

Usage

```
ml_dadas(
  model,
  predictor,
  diff_var,
  diff_var_values,
  scaled_estimates = FALSE,
  re_cov_test = FALSE,
  var_boot_test = FALSE,
  nsim = NULL,
  level = 0.95,
  seed = NULL
)
```

Arguments

model	Multilevel model fitted with lmerTest.
predictor	Character string. Variable name of independent variable predicting difference score.
diff_var	Character string. A variable indicative of difference score components (two groups).
diff_var_values	Vector. Values of the component score groups in diff_var.
scaled_estimates	Logical. Are scaled estimates obtained? Does fit a reduced model for correct standard deviations. (Default FALSE)
re_cov_test	Logical. Significance test for random effect covariation? Does fit a reduced model without the correlation. (Default FALSE)
var_boot_test	Logical. Compare variance by lower-level groups at the upper-level in a reduced model with bootstrap? (Default FALSE)
nsim	Numeric. Number of bootstrap simulations.
level	Numeric. The confidence level required for the var_boot_test output (Default .95)
seed	Numeric. Seed number for bootstrap simulations.

Value

dadas	A data frame including regression coefficients for component scores and dadas.
scaled_estimates	Scaled regression coefficients for difference score components and difference score.
vpc_at_reduced	Variance partition coefficients in the model without the predictor and interactions.
re_cov_test	Likelihood ratio significance test for random effect covariation.
boot_var_diffs	List of different variance bootstrap tests.

Examples

```
## Not run:
set.seed(95332)
n1 <- 10 # groups
n2 <- 10 # observations per group

dat <- data.frame(
  group = rep(c(LETTERS[1:n1]), each = n2),
  x = sample(c(-0.5, 0.5), n1 * n2, replace = TRUE),
  w = rep(sample(1:5, n1, replace = TRUE), each = n2),
  y = sample(1:5, n1 * n2, replace = TRUE)
)
library(lmerTest)
fit <- lmerTest::lmer(y ~ x * w + (x | group),
  data = dat
)

round(ml_dadas(fit,
  predictor = "w",
  diff_var = "x",
  diff_var_values = c(0.5, -0.5)
)$dadas, 3)

## End(Not run)
```

---

pcc *Returns probabilities of correct classification for both groups in independent data partition.*

Description

Returns probabilities of correct classification for both groups in independent data partition.

Usage

```
pcc(data, pred.var, group.var, group.values)
```

Arguments

data	Data frame including predicted values (e.g., pred.dat from D_regularized_out).
pred.var	Character string. Variable name for predicted values.
group.var	The name of the group variable.
group.values	Vector of length 2, group values (e.g. c("male", "female) or c(0,1)).

Value

Vector of length 2. Probabilities of correct classification.

Examples

```
D_out <- D_regularized_out(
  data = iris[iris$Species == "versicolor" | iris$Species == "virginica", ],
  mv.vars = c("Sepal.Length", "Sepal.Width", "Petal.Length", "Petal.Width"),
  group.var = "Species", group.values = c("versicolor", "virginica"),
  size = 15
)

pcc(
  data = D_out$pred.dat,
  pred.var = "pred",
  group.var = "group",
  group.values = c("versicolor", "virginica")
)
```

---

reliability_dms *Reliability calculation for difference score variable that is a difference between two mean variables calculated over upper-level units (e.g., sex differences across countries)*

Description

Calculates reliability of difference score (Johns, 1981) based on two separate ICC2 values (Bliese, 2000), standard deviations of mean values over upper-level units, and correlations between the mean values across upper-level units.

Usage

```
reliability_dms(
  model = NULL,
  data = NULL,
  diff_var,
  diff_var_values,
  var,
  group_var
)
```

Arguments

model	Multilevel model fitted with lmer (default NULL)
data	Long format data frame (default NULL)
diff_var	Character string. A variable indicative of difference score components (two groups).
diff_var_values	Vector. Values of the component score groups in diff_var.
var	Character string. Name of the dependent variable or variable of which mean values are calculated.
group_var	Character string. Upper-level clustering unit.

Value

A vector including ICC2s (r11 and r22), SDs (sd1 and sd2), correlation between means (r12), and reliability of the mean difference variable.

References

Bliese, P. D. (2000). Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. In K. J. Klein & S. W. J. Kozlowski (Eds.), Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions (pp. 349–381). Jossey-Bass.

Johns, G. (1981). Difference score measures of organizational behavior variables: A critique. Organizational Behavior and Human Performance, 27(3), 443–463. https://doi.org/10.1016/0030-5073(81)90033-7

Examples

```
set.seed(4317)
n2 <- 20
n1 <- 200
ri <- rnorm(n2, m = 0.5, sd = 0.2)
rs <- 0.5 * ri + rnorm(n2, m = 0.3, sd = 0.15)
d.list <- list()
for (i in 1:n2) {
  x <- rep(c(-0.5, 0.5), each = n1 / 2)
  y <- ri[i] + rs[i] * x + rnorm(n1)
  d.list[[i]] <- cbind(x, y, i)
}

d <- data.frame(do.call(rbind, d.list))
names(d) <- c("x", "y", "cntry")
reliability_dms(
  data = d, diff_var = "x",
  diff_var_values = c(-0.5, 0.5), var = "y", group_var = "cntry"
)
```

---

sem_dadas *Predicting algebraic difference scores in structural equation model*

Description

Predicting algebraic difference scores in structural equation model

Usage

```
sem_dadas(
  data,
  var1,
  var2,
```

```
  center = FALSE,
  scale = FALSE,
  predictor,
  covariates = NULL,
  estimator = "MLR",
  level = 0.95,
  sampling.weights = NULL
)
```

Arguments

data	A data frame.
var1	Character string. Variable name of first component score of difference score (Y_1).
var2	Character string. Variable name of second component score of difference score (Y_2).
center	Logical. Are var1 and var2 centered around their grand mean? (Default FALSE)
scale	Logical. Are var1 and var2 scaled with their pooled sd? (Default FALSE)
predictor	Character string. Variable name of independent variable predicting difference score.
covariates	Character string or vector. Variable names of covariates (Default NULL).
estimator	Character string. Estimator used in SEM (Default "MLR").
level	Numeric. The confidence level required for the result output (Default .95)
sampling.weights	Character string. Name of sampling weights variable.

Value

descriptives	Means, standard deviations, and intercorrelations.
parameter_estimates	Parameter estimates from the structural equation model.
variance_test	Variances and covariances of component scores.
transformed_data	Data frame with variables used in SEM.
dadas	One sided dadas-test for positivity of abs(b_11-b_21)-abs(b_11+b_21).
results	Summary of key results.

References

Edwards, J. R. (1995). Alternatives to Difference Scores as Dependent Variables in the Study of Congruence in Organizational Research. Organizational Behavior and Human Decision Processes, 64(3), 307–324.

Examples

```
## Not run:
set.seed(342356)
d <- data.frame(
  var1 = rnorm(50),
  var2 = rnorm(50),
  x = rnorm(50)
)
sem_dadas(
  data = d, var1 = "var1", var2 = "var2",
  predictor = "x", center = TRUE, scale = TRUE
)$results

## End(Not run)
```

`vpc_at` *Variance partition coefficient calculated at different level-1 values*

Description

Calculates variance estimates (level-2 Intercept variance) and variance partition coefficients (i.e., intra-class correlation) at selected values of predictor values in two-level linear models with random effects (intercept, slope, and their covariation).

Usage

```
vpc_at(model, lvl1.var, lvl1.values)
```

Arguments

`model`	Two-level model fitted with lme4. Must include random intercept, slope, and their covariation.
`lvl1.var`	Character string. Level 1 variable name to which random slope is also estimated.
`lvl1.values`	Level 1 variable values.

Value

Data frame of level 2 variance and std.dev. estimates at level 1 variable values, respective VPCs (ICC1s) and group-mean reliabilities (ICC2s) (Bliese, 2000).

References

Goldstein, H., Browne, W., & Rasbash, J. (2002). Partitioning Variation in Multilevel Models. Understanding Statistics, 1(4), 223–231. https://doi.org/10.1207/S15328031US0104_02

Bliese, P. D. (2000). Within-group agreement, non-independence, and reliability: Implications for data aggregation and analysis. In K. J. Klein & S. W. J. Kozlowski (Eds.), Multilevel theory, research, and methods in organizations: Foundations, extensions, and new directions (pp. 349–381). Jossey-Bass.

Examples

```
fit <- lme4::lmer(Sepal.Length ~ Petal.Length +
  (Petal.Length | Species),
data = iris
)

lvl1.values <-
  c(
    mean(iris$Petal.Length) - stats::sd(iris$Petal.Length),
    mean(iris$Petal.Length),
    mean(iris$Petal.Length) + stats::sd(iris$Petal.Length)
  )

vpc_at(
  model = fit,
  lvl1.var = "Petal.Length",
  lvl1.values = lvl1.values
)
```

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