Package 'pamm'

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Description Simulation functions to assess or explore the power of a dataset to estimates significant random effects (intercept or slope) in a mixed model. The functions are based on the ``lme4" and ``lmerTest" packages.

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pamm-package   *pamm: Power Analysis for Random Effects in Mixed Models*

Description

Simulation functions to assess or explore the power of a dataset to estimates significant random effects (intercept or slope) in a mixed model. The functions are based on the "lme4" and "lmerTest" packages.

Author(s)

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See Also

Useful links:

- <https://github.com/JulienGAMartin/pamm_R>
- Report bugs at <https://github.com/JulienGAMartin/pamm_R/issues>

EAMM   *Simulation function for exploratory power analysis for random effects*

Description

Given a specific sample size, fixed number of group and replicates per group, the function simulate different variance-covariance structure and assess p-values and power of random intercept and random slope

Usage

```
EAMM(
  numsim,
  group,
  repl,
  fixed = c(0, 1, 0),
  VI = seq(0.05, 0.95, 0.05),
  VS = seq(0.05, 0.5, 0.05),
  CoIS = 0,
  relIS = "cor",
  n.X = NA,
  autocorr.X = 0,
  X.dist = "gaussian",
  intercept = 0,
```

```
    heteroscedasticity = c("null"),
    mer.sim = TRUE,
    mer.model = NULL
)
```

Arguments

`numsim`	number of simulation for each step
`group`	number of group
`repl`	number of replicates per group
`fixed`	vector of lenght 3 with mean, variance and estimate of fixed effect to simulate. Default: `c(0, 1, 0)`
`VI`	variance component of intercept. Could be specified as a vector. Default: `seq(0.05, 0.95, 0.05)`
`VS`	Variance component of the slope or IxE. Could be specified as a vector. Default: `seq(0.05, 0.5, 0.05)`
`CoIS`	value of correlation or covariance between random intercept and random slope. Default: 0
`relIS`	"cor" or "cov" set the type of relation give in CoIS. By default the relation is set to correlation
`n.X`	number of different values to simulate for the fixed effect (covariate). If `NA`, all values of X are independent between groups. If the value specified is equivalent to the number of replicates per group, `repl`, then all groups are observed for the same values of the covariate. Default: `NA`
`autocorr.X`	correlation between two successive covariate value for a group. Default: `0`
`X.dist`	specify the distribution of the fixed effect. Only "gaussian" (normal distribution) and "unif" (uniform distribution) are accepted actually. Default: `"gaussian"`
`intercept`	a numeric value giving the expected intercept value. Default: 0
`heteroscedasticity`	
	a vector specifying heterogeneity in residual variance across X. If `c("null")` residual variance is homogeneous across X. If `c("power",t1,t2)` models heterogeneity with a constant plus power variance function. Letting v denote the variance covariate and $\sigma^2(v)$ denote the variance function evaluated at v, the constant plus power variance function is defined as $\sigma^2(v) = (\theta_1 + |v|^{\theta_2})^2$, where θ_1, θ_2 are the variance function coefficients. If `c("exp",t)`,models heterogeneity with an exponential variance function. Letting v denote the variance covariate and $\sigma^2(v)$ denote the variance function evaluated at v, the exponential variance function is defined as $\sigma^2(v) = e^{2*\theta*v}$, where θ is the variance function coefficient. Default:"Null"
`mer.sim`	Use the simluate.merMod function to simulate the data. Potentially faster for large dataset but more restricted in terms of options
`mer.model`	Simulate the data based on a existing data and model structure from a lmer object. Should be specified as a list of 3 components: a mer object fitted via lmer, an environmental covariate for which to test the random slope, a random effect (e.g. `list(fm1,"Days","Subject")`)

Details

P-values for random effects are estimated using a log-likelihood ratio test between two models with and without the effect. Power represent the percentage of simulations providing a significant p-value for a given random structure. Residual variance, e, is calculted as 1-VI.

Value

data frame reporting estimated P-values and power with CI for random intercept and random slope

See Also

[PAMM()], [SSF()] for other simulations [plot.EAMM()] for plotting output

Examples

```
## Not run:
ours <- EAMM(
  numsim = 10, group = 10, repl = 4, fixed = c(0, 1, 1),
  VI = seq(0.1, 0.3, 0.05), VS = seq(0.05, 0.2, 0.05)
)
plot(ours, "both")

(fm1 <- lmer(Reaction ~ Days + (Days | Subject), sleepstudy))
ours2 <- EAMM(
  numsim = 10,
  mer.model = list(model = fm1, env = "Days", random = "Subject"),
  VI = seq(0.3, 0.5, 0.1), VS = seq(0.05, 0.2, 0.05)
)
plot(ours2, "both")

## End(Not run)
```

PAMM   *Simulation function to assess power of mixed models*

Description

Given a specific varaince-covariance structure for random effect, the function simulate different group size and assess p-values and power of random intercept and random slope

Usage

```
PAMM(
  numsim,
  group,
  repl,
  randompart,
```

```
    fixed = c(0, 1, 0),
    n.X = NA,
    autocorr.X = 0,
    X.dist = "gaussian",
    intercept = 0,
    heteroscedasticity = c("null"),
    ftype = "lmer",
    mer.sim = FALSE
)
```

Arguments

numsim	number of simulation for each step
group	number of group. Could be specified as a vector
repl	number of replicates per group . Could be specified as a vector
randompart	vector of lenght 4 or 5, with 1: variance component of intercept, VI; 2: variance component of slope, VS; 3: residual variance, VR; 4: relation between random intercept and random slope; 5: "cor" or "cov" determine if the relation 4 between I ans S is a correlation or a covariance. Default: "cor"
fixed	vector with mean, variance and estimate of fixed effect to simulate. Default: c(0, 1, 0)
n.X	number of different values to simulate for the fixed effect (covariate). If NA, all values of X are independent between groups. If the value specified is equivalent to the number of replicates per group, repl, then all groups are observed for the same values of the covariate. Default: NA
autocorr.X	correlation between two successive covariate value for a group. Default: 0
X.dist	specify the distribution of the fixed effect. Only "gaussian" (normal distribution) and "unif" (uniform distribution) are accepted actually. Default: "gaussian"
intercept	a numeric value giving the expected intercept value. Default:0
heteroscedasticity	a vector specifying heterogeneity in residual variance across X. If c("null") residual variance is homogeneous across X. If c("power",t1,t2) models heterogeneity with a constant plus power variance function. Letting v denote the variance covariate and $\sigma^2(v)$ denote the variance function evaluated at v, the constant plus power variance function is defined as $\sigma^2(v) = (\theta_1 + |v|^{\theta_2})^2$, where θ_1, θ_2 are the variance function coefficients. If c("exp",t),models heterogeneity with an exponential variance function. Letting v denote the variance covariate and $\sigma^2(v)$ denote the variance function evaluated at v, the exponential variance function is defined as $\sigma^2(v) = e^{2*\theta*v}$, where θ is the variance function coefficient.
ftype	character value "lmer", "lme" or "MCMCglmm" specifying the function to use to fit the model. Actually "lmer" only is accepted
mer.sim	simulate the data using simulate.merMod from lme4. Faster for large sample size but not as flexible.

Details

P-values for random effects are estimated using a log-likelihood ratio test between two models with and without the effect. Power represent the percentage of simulations providing a significant p-value for a given random structure

Value

data frame reporting estimated P-values and power with CI for random intercept and random slope

\@seealso [EAMM()], [SSF()], [plot.PAMM()]

Examples

```
## Not run:
ours <- PAMM(numsim = 10, group = c(seq(10, 50, 10), 100),
             repl = c(3, 4, 6),
             randompart = c(0.4, 0.1, 0.5, 0.1), fixed = c(0, 1, 0.7))
plot(ours,"both")

## End(Not run)
```

---

plot.EAMM   *Graphic output of the EAMM function*

Description

Provide graphic interpretation of the simulation results

Usage

```
## S3 method for class 'EAMM'
plot(x, graphtype = "both", vi, vs, fun3D = "wireframe", ...)
```

Arguments

x	an EAMM object
graphtype	"VI", "VS", or "both" "VI" give graphs with varying variance component of intercept and with a fixed variance component for slope specified in vs argument "VS" give graphs with varying variance component for slope and with a fixed variance component of intercept specified in vi argument "both" 3-D plot see also fun3D argument
vi	VI for which plots the output. Necessary for "VS" type of graph
vs	VS for which plots the output. Necessary for "VI" type of graph
fun3D	plot function used to plot the 3D graph. "wireframe" uses lattice, "persp" uses graphics, and "open3d" uses rgl.
...	potentially further arguments to pass to methods

Examples

```
## Not run:
  ours <- EAMM(numsim=10, group=10, repl=4,
               VI=seq(0.1,0.95,0.05), VS=c(0.05,0.1) )
  plot(ours, "both")
  plot(ours, "VI",vs=0.1)
  plot(ours,"VS",vi=0.2)

## End(Not run)
```

---

plot.PAMM   *Graphic output of the PAMM function*

Description

Provide graphic interpretation of the simulation results

Usage

```
## S3 method for class 'PAMM'
plot(x, graphtype = "both", nbgroup, nbrepl, fun3D = "wireframe", ...)
```

Arguments

x	a PAMM object
graphtype	"group", "repl" or "both" "group" give graphs with varying number of ID and with a fixed number of replicates specified in nbrepl "repl" give graphs with varying number of replicates and with a fixed number of ID specified in nbgroup "both" 3-D plot. see also fun3D argument. Note: useful only with multiple group size and multiple number of replicates.
nbgroup	number of group for which plots the output. Necessary for "repl" type of graph
nbrepl	number of replicates for which plots the output. Necessary for "group" type of graph
fun3D	plot function used to plot the 3D graph. "wireframe" uses lattice, "persp" uses graphics and "open3d" uses rgl
...	potentially further arguments to pass to methods

Details

Parameters phi, theta, ticktype ("simple" or "detailed"), nticks, nbcol from [persp()] function could also be specified for 3D plots. In addition, color schemes ("grey", "cm.colors" and "rainbow") and coltype ("restricted" or "0-1") parameters could also be specified for 3D plots.

Exampes

```
## Not run:
  ours <- PAMM(numsim=10,group=c(seq(10,50,10),100),repl=c(3,4,6),
            randompart=c(0.4,0.1,0.5,0.1),fixed=c(0,1,0.7))
  plot(ours, "both")
  plot(ours, "group",nbrepl=4)
  plot(ours,"repl",nbgroup=20)

## End(Not run)
```

---

plot.SSF   *Graphic output of the PAMM function*

Description

Provide graphic interpretation of the simulation results

Usage

```
## S3 method for class 'SSF'
plot(x, ...)
```

Arguments

x   an SSF object

...   potentially further arguments to pass to methods

Examples

```
## Not run:
  oursSSF <- SSF(50,100,10,c(0.4,0.1,0.6,0))
  plot(oursSSF)

## End(Not run)
```

SSF   *Simulation function to assess power of mixed models*

Description

Given a specific total number of observations and variance-covariance structure for random effect, the function simulates different association of number of group and replicates, giving the specified sample size, and assess p-values and power of random intercept and random slope

Usage

```
SSF(
  numsim,
  tss,
  nbstep = 10,
  randompart,
  fixed = c(0, 1, 0),
  n.X = NA,
  autocorr.X = 0,
  X.dist = "gaussian",
  intercept = 0,
  exgr = NA,
  exrepl = NA,
  heteroscedasticity = c("null")
)
```

Arguments

numsim	number of simulation for each step
tss	total sample size, nb group * nb replicates
nbstep	number of group*replicates associations to simulate
randompart	vector of lenght 4 or 5 with 1: variance component of intercept, VI; 2: variance component of slope, VS; 3: residual variance, VR; 4: relation between random intercept and random slope; 5: "cor" or "cov" determine id the relation between I ans S is correlation or covariance, set to "cor" by default
fixed	vector of lenght 3 with mean, variance and estimate of fixed effect to simulate
n.X	number of different values to simulate for the fixed effect (covariate). If NA, all values of X are independent between groups. If the value specified is equivalent to the number of replicates per group, repl, then all groups are observed for the same values of the covariate. Default: NA
autocorr.X	correlation between two successive covariate value for a group. Default: 0
X.dist	specify the distribution of the fixed effect. Only "gaussian" (normal distribution) and "unif" (uniform distribution) are accepted actually. Default: "gaussian"
intercept	a numeric value giving the expected intercept value. Default:0

exgr   a vector specifying minimum and maximum value for number of group. De-
                              fault:`c(2,tss/2)`

exrepl   a vector specifying minimum and maximum value for number of replicates. De-
                              fault:`c(2,tss/2)`

heteroscedasticity
                              a vector specifying heterogeneity in residual variance across X. If `c("null")`
                              residual variance is homogeneous across X. If `c("power",t1,t2)` models het-
                              erogeneity with a constant plus power variance function. Letting v denote the
                              variance covariate and $\sigma^2(v) s2(v)$ denote the variance function evaluated at
                              v, the constant plus power variance function is defined as $\sigma^2(v) = (\theta_1 + |v|^{\theta_2})^2 s2(v) = (t1 + |v|^t2)^2$, where $\theta_1, \theta_2 t1, t2$ are the variance function co-
                              efficients. If `c("exp",t)`,models heterogeneity with an exponential variance
                              function. Letting v denote the variance covariate and $\sigma^2(v) s2(v)$ denote the
                              variance function evaluated at v, the exponential variance function is defined
                              as $\sigma^2(v) = e^{2*\theta*v} s2(v) = exp(2 * t * v)$, where θ is the variance function
                              coefficient.

Details

P-values for random effects are estimated using a log-likelihood ratio test between two models
with and without the effect. Power represent the percentage of simulations providing a significant
p-value for a given random structure

Value

data frame reporting estimated P-values and power with CI for random intercept and random slope

See Also

PAMM(), EAMM() for other simulation functions plot.SSF() for plotting

Examples

```
## Not run:
oursSSF <- SSF(10, 100, 10, c(0.4, 0.1, 0.6, 0))
plot(oursSSF)

## End(Not run)
```

Index