Overview of the package LMMstar

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This vignette describes the main functionalities of the **LMMstar** package. This package implements specific types of multivariate Gaussian models mainly useful when having repeated observations over a discrete variable (e.g. time, brain region, ...). Key assumptions are that at the cluster level, observation are independent and identically distributed and that the mean and variance are driven by independent factors. In particular, in large sample the residuals do not have to be normally distributed.

The **LMMstar** package contains four main functions:

- the function `lmm` is the main function of the package which fits multivariate Gaussian models. The user can interact with *lmm* objects using:
  - `anova` to test combinations of coefficients (Wald test or Likelihood ratio tests)
  - `coef` to extract the estimates.
  - `confint` to extract estimates, confidence intervals, and p.values.
  - `getVarCov` to extract the modeled residual variance covariance matrix.
  - `logLik` to output the log-likelihood of the estimated model.
  - `predict` to compute the conditional mean for new observations.
  - `residuals` to extract the observed residuals of the fitted model.
  - `summary` to obtain a summary of the results
- the `summarize` function to compute summary statistics stratified on a categorical variable (typically time).
- the `sampleRem` function to simulate longitudinal data.
- the `LMMstar.options` function enables the user to display the default values used in the **LMMstar** package. function. The function can also change the default values to better match the user needs.

Before going further we need to load the **LMMstar** package in the R session:

```
library(LMMstar)
```

To illustrate the functionalities of the package, we will use the `veteran` dataset:

```
data(gastricbypassL)
head(gastricbypassL)
```

```
  id visit                    time weight glucagon
1  1     1 3 months before surgery  127.2  5032.50
2  2     1 3 months before surgery  165.2 12142.50
3  3     1 3 months before surgery  109.7 10321.35
4  4     1 3 months before surgery  146.2  6693.00
5  5     1 3 months before surgery  113.1  7090.50
6  6     1 3 months before surgery  158.8 10386.00
```

See `?gastricbypassL` for a presentation of the database.

Note: the **LMMstar** package is under active development. Newer package versions may include additional functionalities and fix previous bugs. The version of the package that is being is:

```
utils::packageVersion("LMMstar")
```

```
[1] '0.2'
```

For completness, the details of the R session used to generate this document are:

```
sessionInfo()
```

```
R version 4.1.0 (2021-05-18)
Platform: x86_64-pc-linux-gnu (64-bit)
Running under: Ubuntu 20.04.2 LTS

Matrix products: default
BLAS:   /usr/lib/x86_64-linux-gnu/blas/libblas.so.3.9.0
LAPACK: /usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.9.0

locale:
 [1] LC_CTYPE=en_US.UTF-8       LC_NUMERIC=C               LC_TIME=en_US.UTF-8
 [4] LC_COLLATE=en_US.UTF-8     LC_MONETARY=en_US.UTF-8    LC_MESSAGES=en_US.UTF-8
 [7] LC_PAPER=en_US.UTF-8       LC_NAME=C                  LC_ADDRESS=C
[10] LC_TELEPHONE=C             LC_MEASUREMENT=en_US.UTF-8 LC_IDENTIFICATION=C

attached base packages:
[1] stats     graphics  grDevices utils     datasets  methods   base

other attached packages:
[1] LMMstar_0.2
```

```
loaded via a namespace (and not attached):
 [1] pillar_1.6.1     compiler_4.1.0   tools_4.1.0      lifecycle_1.0.0  tibble_3.1.2
 [6] gtable_0.3.0     nlme_3.1-152     lattice_0.20-44  pkgconfig_2.0.3  rlang_0.4.11
[11] Matrix_1.3-3     mvtnorm_1.1-1    coda_0.19-4      dplyr_1.0.6      generics_0.1.0
[16] vctrs_0.3.8      grid_4.1.0       tidyselect_1.1.1 glue_1.4.2       R6_2.5.0
[21] fansi_0.4.2      survival_3.2-11  multcomp_1.4-17  lava_1.6.9       TH.data_1.0-10
[26] ggplot2_3.3.3    purrr_0.3.4      magrittr_2.0.1   scales_1.1.1     codetools_0.2-18
[31] ellipsis_0.3.2   emmeans_1.6.0    MASS_7.3-54      splines_4.1.0    xtable_1.8-4
[36] colorspace_2.0-1 sandwich_3.0-1   utf8_1.2.1       estimability_1.3 munsell_0.5.0
[41] crayon_1.4.1     zoo_1.8-9
```

1 Modifying default options

2 Modifying default options

The `LMMstar.options` method enable to get and set the default options used by the package. For instance, the default option for the information matrix is:

```
LMMstar.options("type.information")
```

```
$type.information
[1] "observed"
```

To change the default option to "expected" (faster to compute but less accurate p-values and confidence intervals in small samples) use:

```
LMMstar.options(type.information = "expected")
```

To restore the original default options do:

```
LMMstar.options(reinitialise = TRUE)
```

References