Package 'fastFGEE'

May 8, 2026

Title Fast Functional Generalized Estimating Equations via a One-Step Estimator

Version 0.1.0

Description Fits functional generalized estimating equations for longitudinal functional outcomes and covariates using a one-step estimator that is fast even for large cluster sizes or large numbers of clusters. The package supports quasi-likelihoods derived from a range of families, common link functions, and several working correlation structures. Uncertainty quantification is based on sandwich variance estimators and bootstrap procedures that remain valid even when the working correlation is incorrectly specified. The package provides an implementation of the method described in Loewinger et al. (2025) <https://pmc.ncbi.nlm.nih.gov/articles/PMC12306803/>. For irregularly spaced AR(1) precision matrices, the package can optionally use the archived package 'irregulAR1'; if needed, it can be obtained from the CRAN Archive at <https://cran.r-project.org/src/contrib/Archive/irregulAR1/>.

License GPL (>= 3)

Encoding UTF-8

RoxygenNote 7.3.3

Depends R (>= 4.2)

Imports data.table, ggplot2, gridExtra, MASS, Matrix, mgcv, refund, Rfast, SuperGauss

Suggests irregulAR1, knitr, rmarkdown, sanic, Rcpp, RcppArmadillo

VignetteBuilder knitr

URL https://github.com/gloewing/fastFGEE

BugReports https://github.com/gloewing/fastFGEE/issues

NeedsCompilation no

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`d` *Simulated longitudinal functional example data*

Description

A simulated dataset used in examples and testing for **fastFGEE**. The object `d` is a data frame containing a functional response stored in an `AsIs` matrix column together with a cluster identifier, two scalar covariates, and a longitudinal time variable.

Usage

```
data(d)
```

Format

A data frame with 5 variables:

`Y` An `AsIs` matrix-valued column containing the functional response. In the included example, the matrix has 100 columns named `Y_1` to `Y_100`.

`ID` Cluster identifier.

`X1` First scalar covariate.

`X2` Second scalar covariate.

`time` Longitudinal time variable.

Details

This dataset is intended for package examples, vignettes, and quick testing of `fgee`. It represents a simulated binary-response setting on a common functional grid.

Source

Simulated for the package examples.

`fgee` *Fits functional generalized estimating equations (fGEE) for longitudinal functional outcomes using a one-step estimator, with optional fully iterated final estimation.*

Description

Fits functional generalized estimating equations (fGEE) for longitudinal functional outcomes using a one-step estimator, with optional fully iterated final estimation.

Usage

```
fgee(
  formula,
  data,
  cluster,
  family,
  corr_fn = "ar1",
  corr_long = "ar1",
  time = NULL,
  long.dir = TRUE,
  var.type = "sandwich",
  pffr.mod = NULL,
  knots = NULL,
  bs = "bs",
  cv = "fastkfold",
  cv.grid = NULL,
  exact = FALSE,
  rho.smooth = FALSE,
  joint.CI = "wild",
  gee.fit = TRUE,
  linpred_method = c("accumulate", "matrix"),
  clip_mu = 0,
  m.pffr = c(2, 1),
  check_alignment = TRUE,
  max.iter = 1,
  tune.method = c("one-step", "fully-iterated"),
  boot.samps = 3000,
  ...
)
```

Arguments

`formula`	A model formula. The left-hand side should be a functional response stored as a matrix-like column (typically wrapped in `I()`).
`data`	A data frame containing the variables in `formula`.

cluster	Name of the cluster identifier column.
family	A family object or family name understood by refund::pffr().
corr_fn	Working correlation in the functional direction. One of "independent", "exchangeable", "ar1", or "fpca".
corr_long	Working correlation in the longitudinal direction. One of "independent", "exchangeable", or "ar1".
time	Optional name of the longitudinal ordering variable.
long.dir	Logical; retained for backwards compatibility.
var.type	Variance estimator. One of "sandwich", "fastboot", or "boot". For bootstraping, we recommend "fastboot" over "boot" because it is more thoroughly tested.
pffr.mod	Optional fitted refund::pffr() object to use as the initial estimator.
knots	Number of spline knots for the initial pffr() fit.
bs	Basis type passed to refund::pffr().
cv	Cross-validation mode used for smoothing parameter selection.
cv.grid	Optional grid (or staged grids) of smoothing parameters.
exact	Logical; for Gaussian identity-link models, use the exact penalized weighted least-squares update.
rho.smooth	Logical; smooth pointwise correlation estimates over the relevant index when applicable.
joint.CI	Logical or character controlling joint confidence intervals.
gee.fit	Logical; if FALSE, return uncertainty quantification around the initial fit without the GEE update.
linpred_method	Method used to form linear predictors.
clip_mu	Lower bound used for numerical stabilization of fitted means.
m.pffr	Penalty order specification passed to refund::pffr().
check_alignment	Logical; check alignment between the wide data and the pffr() long representation.
max.iter	Maximum number of GEE iterations. 1 gives the one-step fit.
tune.method	Smoothing-parameter tuning method.
boot.samps	Number of bootstrap replicates used when applicable.
...	Additional arguments reserved for future use.

Value

A "fgee1step" object. pffr_initial.fit contains the initial fit refund::pffr object. vb contains the variance/covariance matrix for the coefficient estimates (sandwich or bootstrap-based). qn contains the joint CI quantiles. di and \ wi are lists of length N, with the updated cluster-specific estimating equation and hessian terms (without the penalty).

Author(s)

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References

Gabriel Loewinger, Alex W. Levis, Erjia Cui, and Francisco Pereira. (2025). Fast Penalized Generalized Estimating Equations for Large Longitudinal Functional Datasets. *arXiv:2506.20437*.

Examples

```
library(fastFGEE)
data("d", package = "fastFGEE")
fit <- fgee(
 formula = Y ~ X1 + X2,
 data = d,
 cluster = "ID",
 family = binomial(link = "logit"),
 time = "time",
 corr_long = "exchangeable",
 corr_fn = "independent")

 fgee.plot(fit)
```

`fgee.plot` *Plot coefficient estimates from a fitted* `fastFGEE` *model*

Description

Produces coefficient plots with pointwise and joint confidence intervals when available.

Usage

```
fgee.plot(
  fit,
  num_row = NULL,
  xlab = "Functional Domain",
  title_names = NULL,
  ylim = NULL,
  align_x = NULL,
  x_rescale = 1,
  y_val_lim = 1.1,
  y_scal_orig = 0.05,
  return = FALSE,
  terms.plot = TRUE,
  all.terms = TRUE,
  int.uncertainty = FALSE
)
```

Arguments

`fit`	A fitted object returned by `fgee`.
`num_row`	Number of rows used when arranging plots.
`xlab`	X-axis label.
`title_names`	Optional replacement titles for coefficient plots.
`ylim`	Optional y-axis limits.
`align_x`	Optional value used to re-center the x-axis.
`x_rescale`	Optional x-axis rescaling factor.
`y_val_lim`	Expansion factor for the upper y-axis limit.
`y_scal_orig`	Expansion factor for the lower y-axis limit.
`return`	Logical; if `TRUE`, return the plotting data instead of only drawing the plots.
`terms.plot`	Logical; retained for backwards compatibility.
`all.terms`	Logical; retained for backwards compatibility.
`int.uncertainty`	Logical; retained for backwards compatibility.

Value

Invisibly returns a list of plotting data frames when `return = TRUE`; otherwise draws plots.

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