

# Package ‘fastFGEE’

April 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 'irregularAR1'; if needed, it can be obtained from the CRAN Archive at <<https://cran.r-project.org/src/contrib/Archive/irregularAR1/>>.

**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** irregularAR1, 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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**Repository** CRAN

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## Contents

d . . . . .	2
fgee . . . . .	3
fgee.plot . . . . .	5
<b>Index</b>	<b>7</b>

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d	<i>Simulated longitudinal functional example data</i>
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### 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.

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fgee	<i>Fits functional generalized estimating equations (fGEE) for longitudinal functional outcomes using a one-step estimator, with optional fully iterated final estimation.</i>
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### 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 <code>I()</code> ).
data	A data frame containing the variables in formula.

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

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fgee.plot

*Plot coefficient estimates from a fitted fastFGEE model*

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**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**

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

**Value**

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

# Index

\* **datasets**

d, [2](#)

d, [2](#)

fgee, [2](#), [3](#), [6](#)

fgee.plot, [5](#)