Package ‘FLIM’

February 19, 2015

Type Package
Title Farewell’s Linear Increments Model
Version 1.2
Date 2014-12-02
Author Rune Hoff with contributions from Jon Michael Gran and Daniel Farewell
Maintainer Rune Hoff <rune.hoff@medisin.uio.no>
Description FLIM fits linear models for the observed increments in a longitudinal dataset, and im-
putes missing values according to the models.
Depends zoo, MASS
Encoding UTF-8
License GPL-2
NeedsCompilation no
Repository CRAN
Date/Publication 2014-12-02 14:30:02

R topics documented:

   FLIM-package ................................................. 2
   CD4sim ....................................................... 3
   flim .......................................................... 3
   flimboot ..................................................... 6
   flimList ..................................................... 7
   flimMean .................................................... 8
   flimSD ....................................................... 8
   panss ......................................................... 9
   plot.flim .................................................... 10
   plot.flimboot ................................................ 11

Index 13
Description

The FLIM package can be used to fit linear models for the observed increments of longitudinal processes found in longitudinal datasets. In addition, it can reconstruct any missing data by imputing estimated values according to the fitted models. The mean structure of the reconstructed data will be correct under certain assumptions. However, imputed data will not exhibit the random variation it should, and pointwise confidence bands can be based on bootstrap samples.

Details

| Package: | FLIM |
| Type:    | Package |
| Version: | 1.1 |
| Date:    | 2013-12-09 |
| License: | GPL-2 |

The model fits and reconstruction is done with the core function `flim`, and mean responses can be calculated with `flimMean`. To investigate results graphically one can use `plot.flim`.

To assess model fits at each observation time after having used `flim`, see `flimList`.

A bootstrap function `flimboot` for "flim" objects is implemented as well.

Author(s)

Rune Hoff with contributions from Jon Michael Gran and Daniel Farewell

Maintainer: Rune Hoff <rune.hoff@medisin.uio.no>

References


### CD4sim

**Simulated HIV data**

**Description**

A simulated dataset of HIV patients undergoing treatment. At each timepoint treatment is initiated with increasing probability as CD4 values for patients are decreasing. Treatment has a positive effect on CD4. The lower the CD4 value, the higher risk the patient has for getting the event AIDS.

**Usage**

```r
data(CD4sim)
```

**Format**

A data frame with 4894 observations on the following 5 variables.

- **id**: id number
- **time**: observation times
- **treat**: treatment indicator
- **cd4**: square root of CD4
- **AIDS**: event indicator

**Source**

Simulated data

**Examples**

```r
data(CD4sim)
```

### flim

**Farewell’s Linear Increments Model**

**Description**

`flim` is the main function in `FLIM` and is used to fit linear models for the observed increments and fill in missing values in a longitudinal dataset according to the linear increments model. The end result is a list of fitted models and a hypothetical complete dataset that can be used for further analysis.
Usage

```r
flim(formulaL dataL idL obstimeL t.values = NULL, method = "locf", lambda = NULL,
art.cens = NULL)
```

## S3 method for class 'flim'
print(x, ...)
## S3 method for class 'flim'
summary(object, ...)

Arguments

- **formula**: an R formula on the form `response ~ predictors`. The package fits models for the increments, so that `formula = Y ~ Y + X`, specifies the model
  \( E(Y(t+1) - Y(t)) = \beta_0(t) + \beta_1(t)Y(t) + \beta_2(t)X(t). \)
  For several responses and the same set of predictors, `cbind(response1, response2) ~ predictors` can be used. For full flexibility a list of formulae can be supplied.

- **data**: a longitudinal dataset in long format. See e.g. `panss`. Only rows corresponding actual observations should be contained in the dataset. Partial observation of some, of potentially many measurement variables, should also be contained as a row in the data, but with the non observed values coded as `NA`. Fully non observed entries should be excluded.
  The dataset needs to include a variable with id numbers, which uniquely identifies the individual subjects under study, and in addition a variable with the timepoints of the observations.

- **id**: name of the column in `data` which uniquely identifies the subjects under study.

- **obstime**: name of the column with observation times

- **t.values**: timepoints at which models should be fitted and missing data imputed. Because of the nature of the algorithm, models are fitted from the first timepoint all the way through to the second to last, and missing data are imputed from the second timepoint to the last. If nothing is specified, this argument will be set to the observation times contained in the data.

- **method**: method for filling in values between observations if there is nonmonotone missingness, options are "locf", "approx", "recursive" and "recursiveX". Default is "locf". See details below.

- **lambda**: ridge parameter for doing ridge regression in the linear fits, default is OLS.

- **art.cens**: used to specify a 0-1 factor variable, for which artificial censoring is performed to response values for all subjects after the first switch from 0 to 1. Missing values will then be imputed as if subjects never made the switch. This is intended for advanced users and does not come with readily available tools for investigating results. Original dataset with added columns for counterfactual response values is stored in fitted object.

- **x**: object of class "flim"

- **object**: object of class "flim"

- **...**: not used.
**Details**

`flim` works by fitting linear models for the increments. At each observation time \( t \), observed increments are regressed onto values of the longitudinal responses and possibly other covariates. Missing values are estimated according to the models and imputed.

To use `flim`, a longitudinal dataset in long/stacked format is required, see e.g `panss`. In addition to longitudinal variable(s) and possibly covariates, the data must contain a variable with ids that uniquely identifies study subjects, and also a time variable of the time of observation. In the case where there is only one longitudinal measurement being recorded, missing observations should not be included a row in the data. If there are more than one response, row entries where all responses are missing should be excluded. If some of the responses are observed for an individual, this row should enter the data and the missing measurement(s) should be coded as `NA`.

The `method` determines how nonmonotone missingness should be handled. "locf" stands for last observation carried forward, "approx" means that missing values are filled in by linear interpolation between two observed values, and "recursive" results in the linear increments model being used throughout. The "recursiveX" option is the same as "recursive", but also utilizes observed data when there are no observed increment (observations with missing data on the previous timepoint), by using the last imputed value to estimate an increment whenever someone returns to the study.

**Value**

`flim` returns an object of class "flim".

Taking summary of a "flim" object will give some information about the reconstruction and fitted models. Hypothetical mean responses can be calculated with `flimMean`. Some graphical options for investigating the imputed data are available in `plot.flim`. To assess the fitted models for increments use `flimList`. For standard error estimates of the mean response, see `flimBoot` and `flimSD`.

An object of class "flim" contains the following components of interest for users:

- **dataset**
  the reconstructed dataset

- **fit**
  a list with the fitted models

**Author(s)**

Rune Hoff

**References**

See FLIM

**Examples**

```r
library(FLIM)
data(panss)
panss.flim <- flim(Y~Y+factor(treat), panss, "id", "time",
                  t.values=c(0,1,2,4,6,8))
plot(panss.flim, "Y", "treat")
flimMean(panss.flim, "Y", "treat")
flimList(panss.flim)
```
summary(flimList(panss.flim))
#plot(flimList(panss.flim),"y")
panss.boot <- flimboot(panss.flim, 20)
flimSD(panss.boot,"y","treat")
plot(panss.boot, "y", "treat")

# Imputing counterfactual CD4 values as if treatment never started
data(CD4sim)
CD4.flim <- flim(cd4 ~ cd4, id="id", obstime="time", data=CD4sim,
art.cens="treat")
# CD4.flim$dataset has added column for counterfactual values

flimboot  FLIM bootstrap function

Description
flimboot can be used to bootstrap an object of class "flim". The function resamples the original
data, and reconstructs each sample with flim.

Usage
flimboot(fo, R, counter = FALSE)
## S3 method for class 'flimboot'
print(x, ...)

Arguments
fo  object of class "flim".
R   number of bootstrap samples.
counter logical. If TRUE displays a bootstrap sample counter. Works by default on Mac
    and Linux platforms.
x   object of class "flimboot".
...  not used.

Details
The resampling is performed on the individuals with replacement, so that if an individual is sampled
to the bootstrap data, the whole set of longitudinal responses for this individual is included.

Value
flimboot returns an object of class "flimboot".
The function plot.flimboot can be used for plotting reconstructed mean responses of the original
"flim" object together with bootstrap confidence bands. Additionally one may calculate the
standard errors for the mean response with flimSD.
An object of class "flimboot" contains the following components
flimList

| org       | the original "flim" object. |
| samples   | a list with the bootstrapped "flim" objects. |

Note

To access the reconstructed bootstrap datasets if needed, type e.g. `flimbootobject$samples[[1]]$df` for the first sample, `flimbootobject$samples[[2]]$df` for the second etc.

Author(s)

Rune Hoff

See Also

`flim, flimSD, plot.flimboot`

---

**flimList**

Assess the fitted models for observed increments

**Description**

Formats and prints the linear fits for observed increments.

**Usage**

```r
flimList(fo)
## S3 method for class 'flimList'
print(x, ...)
## S3 method for class 'flimList'
summary(object, ...)
## S3 method for class 'flimList'
plot(x, response, ...)
```

**Arguments**

- `fo`: an object of class "flim"
- `x`: an object of class "flimList"
- `object`: an object of class "flimList"
- `response`: name of a response variable in the model formula. Plot diagnostics for the linear model for this response will be shown at the different timepoints starting on the first, and jumps to next when <ENTER> is pressed.
- `...`: not used.

**Value**

Returns an object of class "flimList" which has corresponding print, summary and plot methods.
Mean response function for FLIM

Description
Calculates mean responses for "flim" objects.

Usage
flimmean(flimobject, response, grouping = NULL)

Arguments
flimobject object of class "flim".
response name of one of the responses in the model formula
grouping optional group/factor variable used in the model.

Details
flimmean takes a fitted "flim" object and calculates the mean response at the observed timepoints.
If some group variable was used as predictor in the model, mean responses can be calculated restricted to different levels of this variable, by specifying the "grouping" argument. See example in flim for usage.

Value
Mean responses for "flim" objects.

Author(s)
Rune Hoff

Standard deviation for bootstrapped hypothetical mean responses.

Description
Calculates the empirical standard deviation of the bootstrapped hypothetical mean responses in a "flimboot" object.

Usage
flimSD(fbo, response, grouping = NULL)
Arguments

fbo "flimboot" object from using flimboot.
response a response variable in the model formula.
grouping optional group/factor variable used in the model

Value

Bootstrap standard deviations for the estimated hypothetical mean response.

Author(s)

Rune Hoff

Description

The PANSS or the Positive and Negative Syndrome Scale is a medical scale used for measuring symptom severity of patients with schizophrenic conditions. panss contains data from a longitudinal study where 3 different treatments were considered. Patients were followed for 8 weeks and PANSS score was recorded on week 0, 1, 2, 4, 6 and 8. The lower PANSS score a patient has, the less symptoms. Data was extracted from a larger, and confidential, set of clinical trial data from a randomised clinical trial.

Usage

data(panss)

Format

A data frame with 685 observations on the following 4 variables.

treat a factor variable with 3 levels
time observation times
y PANSS score
id id number

Note

Data was reshaped from the source with reshape

Source

http://www.lancaster.ac.uk/staff/diggle/APTS-data-sets/PANSS_short_data.txt

Examples

```r
library(flim)
data(panss)
head(panss, 8)
```

plot.flim  
*Plot function for flim objects.*

Description

Can be used to plot the imputed data. Either one can plot mean responses, or another option is to plot individual trajectories in a spaghetti plot. For plot options for model fits, see `flimList`.

Usage

```r
## S3 method for class 'flim'
plot(x, response = NULL, grouping = NULL, ylim = NULL, col = NULL, naive = TRUE,
     lty = 1:2, ptype = "mean", ylab = "response", xlab = "time", ...)
```

Arguments

- `x`: object of class "flim"
- `response`: name of a longitudinal response
- `grouping`: optional group/factor variable used in the model.
- `ylim`: plot limits for the y-axis. Default is autogenerating suitable limits.
- `col`: Optional colors for each level of the variable grouping.
- `naive`: logical. If TRUE the observed mean response is plotted as well.
- `lty`: Should be left to default, but may be specified if needed. The default is that observed values are full drawn, and hypothetical values are stipulated.
- `ptype`: specifies the plot type, options are "mean" which is default, or "spa" for spaghetti plots of all individual trajectories.
- `ylab`: label of y-axis
- `xlab`: label of x-axis
- `...`: additional arguments passed to `plot`.

Details

`plot.flim` is used to either plot mean trajectories for longitudinal responses or individual trajectories. Users need to specify which response variable should be plotted with the `response` argument. The mean response may be split into several trajectories (with separate coloring) corresponding to the different levels of a factor variable, by specifying the `grouping` argument. Both response and grouping should be entered with quotation marks, e.g. `grouping = "treatment". The `col` argument can be used to determine the colors of plots for different levels of the grouping variable, e.g. `col = c("red", "blue")` for a dichotomous variable, but may also be used without any grouping to specify the color of the plot. Any other arguments that can be passed to `plot` can be entered. See example on usage at the bottom of `flim` help file.
Value

Response measurement plots for reconstructed and observed data.

Author(s)

Rune hoff

plot.flimboot  

Plot function for "flimboot" objects.

Description

Plots hypothetical mean responses for a longitudinal dataset reconstructed with flim, together with point wise bootstrapped confidence bands.

Usage

```r
## S3 method for class 'flimboot'
plot(x, response, grouping=NULL, col=1:20, ylab="Response",
xlab="Times", ylim=NULL, main=NULL, ..., )
```

Arguments

x       "flimboot" object from using flimboot.
response a response variable in the model formula.
grouping optional group/factor variable in the model formula.
col     optional colors for each level of the group variable.
ylab    title for the y axis.
xlab    title for the x axis.
ylim    range limit for the y axis; if nothing is specified it will auto adjust.
main    an overall title for the plot
...     additional arguments passed to plot, except lty which should be left unspeci-
        fied.

Details

Note that here the hypothetical mean responses are plotted with full-drawn lines, and confidence bands are in the same color but stipulated. The observed mean responses are not plotted. The confidence bands are calculated as hypothetical mean response ± two times the bootstrap standard deviation at each time point. The standard error estimates are available with flimSD, see flim for example on usage.
Value

Mean response plot with point wise bootstrap confidence bands.

Author(s)

Rune Hoff
Index

*Topic bootstrap
  flimboot, 6
  plot.flimboot, 11
*Topic datasets
  CD4sim, 3
  panss, 9
*Topic package
  FLIM-package, 2
*Topic plotting
  plot.flim, 10
*Topic standard deviation
  flimSD, 8

CD4sim, 3

FLIM, 3, 5, 6
FLIM (FLIM-package), 2
flim, 2, 3, 6–8, 10, 11
FLIM-package, 2
flimboot, 2, 5, 6, 9, 11
flimList, 2, 5, 7, 10
flimMean, 2, 5, 8
flimSD, 5–7, 8, 11

panss, 4, 5, 9
plot, 10
plot.flim, 2, 5, 10
plot.flimboot, 6, 7, 11
plot.flimList (flimList), 7
print.flim (flim), 3
print.flimboot (flimboot), 6
print.flimList (flimList), 7

reshape, 9

summary.flim (flim), 3
summary.flimList (flimList), 7