

# Package ‘Actigraphy’

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**Title** Actigraphy Data Analysis

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## R topics documented:

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Actigraphy-package      *Functional Actigraphy Data Analysis*

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**Description**

Implements functional linear modeling and analysis for actigraphy data

**Details**

Please refer to the directory "Actigraphy/doc" for an additional tutorials and a document containing the code for the figures in the referenced paper.

The paper can be downloaded from the Journal of Circadian Rhythms website.

**Author(s)**

William D. Shannon, Tao Li, Hong Xian, Jia Wang, Elena Deych, Carlos Gonzalez

**References**

1. "Measuring the Impact of AHI and Obesity on Circadian Activity Patterns Using Functional Linear Modeling of Actigraphy Data," Jia Wang, Amy Licis, Elena Deych, Jimin Ding, Jennifer McLeland, Cristina Toedebusch, Tao Li, Hong Xian, Stephen Duntley, and William Shannon.

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act\_29pt      *Data Set Containing a One Day Average of Actigraph Data for 29 Subjects*

---

**Description**

A data set containing a one day(1440 minutes) of actigraph data for 29 subjects.

**Usage**

```
data(act_29pt)
```

**Format**

A data frame in which each column contains the actigraph data of a subject with column names being the subject IDs. The row names are the time indices of one day by minute from midnight to midnight.

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|         |   |
|---------|---|
| act_8pt | <i>Data Set Containing a One Day Average of Actigraph Data for 8 Subjects</i> |
|---------|---|

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**Description**

A data set containing a one day(1440 minutes) of actigraph data for 8 subjects.

**Usage**

```
data(act_8pt)
```

**Format**

A data frame in which each column contains the actigraph data of a subject with column names being the subject IDs. The row names are the time indices of one day by minute from midnight to midnight.

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|              |  |
|--------------|--|
| cat_flm_plot | <i>Plot Functional Linear Model Analysis Results of a Categorical Type</i> |
|--------------|--|

---

**Description**

This function produce either one or two plots: An effect of a categorical (factor) covariate on activity values by time and potentially the F-test for the effect of the categorical covariate.

**Usage**

```
cat_flm_plot(smoothdata, matchresults, flmresults, ftest,
nperm, lb, xat, varname, col, ylim, L, xlab="Time", ylab="Activity")
```

**Arguments**

|              |   |
|--------------|---|
| smoothdata   | List output from the fda.smoothdata function  |
| matchresults | List output from the matchid function.  |
| flmresults   | List output from the flm_cate function.   |
| ftest        | A logic value indicating whether to implement F test or not. F test will be implement if ftest is TRUE. |
| nperm        | The number of permutations for the F-test.  |
| lb           | X axis labels.  |
| xat          | X axis label positions.   |
| varname      | Name of categorical covariate.  |
| col          | Colors for levels of the predictor.   |

ylim            Y axis limits for activity plot.  
 L                The length of the time points.  
 xlab            The label for the x-axis.  
 ylab            The label for the y-axis.

### Value

One plot of the estimated group means and a possible second plot of the F-test results.

### Author(s)

William D. Shannon, Tao Li, Hong Xian, Jia Wang, Elena Deych, Carlos Gonzalez

### Examples

```
data(act_29pt)
data(clinic_29pt_ahi)

data <- act_29pt
ahi <- clinic_29pt_ahi

ahi$ahicat <- as.factor(ifelse(ahi$AHI >= 0 & ahi$AHI <= 5, 1,
ifelse(ahi$AHI > 5 & ahi$AHI <= 15, 2,
ifelse(ahi$AHI > 15 & ahi$AHI <= 30, 3,
ifelse(ahi$AHI > 30, 4, 0))))))

matchidb <- fda.matchid(data, ahi[,-2] , "factor",
c("normal", "mild", "moderate", "severe"))
FDcatahi <- fda.smoothdata(matchidb)

L <- nrow(data)
lb <- c("Midnight", "6AM", "Noon", "6PM", "Midnight")
xat <- c(0, L/4, L/2, 3*L/4, L)

geftFDcatahi <- flm_cate(FDcatahi)
predy <- as.vector(geftFDcatahi$freg$yhatfdoobj$y)

xlim <- c(0, L)
ylim <- c(min(predy), max(predy) + 100)

cat.flm.results <- cat_flm_plot(FDcatahi, matchidb, geftFDcatahi,
TRUE, 5, lb, xat, "AHI", 1:4, ylim, L)
```

**Description**

A data set containing the AHI(Apnea Hypopnea Index) values(continuous) for 29 subjects.

**Usage**

```
data(clinic_29pt_ahi)
```

**Format**

A data frame consisting of two columns. The first column contains the numeric IDs and the second column contains the AHI information of the 29 subjects.

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|                 |  |
|-----------------|--|
| clinic_29pt_bmi | <i>Data Set Containing BMI(Body Mass Index) Information from 29 Subjects</i> |
|-----------------|--|

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**Description**

A data set containing the BMI(Body Mass Index) values(continuous) for 29 subjects.

**Usage**

```
data(clinic_29pt_bmi)
```

**Format**

A data frame consisting of two columns. The first column contains the numeric IDs and the second column contains the BMI of the 29 subjects.

---

|            |  |
|------------|--|
| clinic_8pt | <i>Data Set Containing AHI(Apnea Hypopnea Index) Information from 8 Subjects</i> |
|------------|--|

---

**Description**

A data set containing the AHI(Apnea Hypopnea Index) values(categorical) for 8 subjects.

**Usage**

```
data(clinic_8pt)
```

**Format**

A data frame that consists of two columns. The first contains the numeric IDs and the second column contains the AHI information for 8 subjects.

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cont\_flm\_plot

*Plot Functional Linear Model Analysis Results of a Continuous Type*


---

### Description

This function produces two plots: An effect of a continuous covariate on activity values by time and the F-test for the effect of the continuous covariate.

### Usage

```
cont_flm_plot(smoothdata, matchresults, flmresults, xlim, ylim,
             fttest, nperm, lb, xat, legendx, legendy, L, xlab="Time", ylab="Activity")
```

### Arguments

|              |   |
|--------------|---|
| smoothdata   | List output from the <code>fda.smoothdata</code> function.  |
| matchresults | List output from the <code>matchid</code> function.   |
| flmresults   | List output from the <code>flm_cate</code> function.  |
| xlim         | X axis limits for activity plot.  |
| ylim         | Y axis limits for activity plot.  |
| fttest       | A logic value indicating whether to implement F test or not. F test will be implement if <code>fttest</code> is TRUE. |
| nperm        | The number of permutations for the F-test.  |
| lb           | X-axis labels.  |
| xat          | X axis label positions.   |
| legendx      | X axis position of the left edge of the legend box.   |
| legendy      | Y axis position of the upper edge of the legend box.  |
| L            | The length of the time points.  |
| xlab         | The label for the x-axis.   |
| ylab         | The label for the y-axis.   |

### Value

One plot of the estimated group means and a possible second plot of the F-test results.

### Author(s)

William D. Shannon, Tao Li, Hong Xian, Jia Wang, Elena Deych, Carlos Gonzalez

**Examples**

```

data(act_29pt)
data(clinic_29pt_ahi)

data <- act_29pt
ahi <- clinic_29pt_ahi

matchid <- fda.matchid(data, ahi, "contin")
FDcont <- fda.smoothdata(matchid)

L <- nrow(data)
lb <- c("Midnight", "6AM", "Noon", "6PM", "Midnight")
xat <- c(0, L/4, L/2, 3*L/4, L)

geftFDcont <- flm_cate(FDcont)
predy <- as.vector(geftFDcont$freg$yhatfdbobj$y)

xlim <- c(0, L)
ylim <- c(min(predy), max(predy) + 100)

legendx <- 0
legendy <- max(predy) - 100

cont.flm.results <- cont_flm_plot(FDcont, matchid, geftFDcont, xlim,
ylim, TRUE, 10, lb, xat, legendx, legendy, L)

```

fda.matchid

*Match IDs from Clinical and Actigraph Data***Description**

A function used to match actigraphy data and clinical covariates by subject IDs and return a list of the data combined by IDs. Only the subjects with both actigraphy and covariate data will be returned by this function.

**Usage**

```
fda.matchid(mat, acov, type, grouplab)
```

**Arguments**

|          |   |
|----------|---|
| mat      | A data frame with the rows being the time and the columns being the activity, with the column names being the subjects. |
| acov     | A two column data frame that contains only subject IDs and a covariate of interest, respectively.                       |
| type     | A string specifying either "contin" for continuous and "factor" for categorical covariates.                             |
| grouplab | A vector of names of the categories if type is TRUE.  |

**Details**

Note: Only the subjects with both actigraphy and covariate data will be returned by this function.

**Value**

A list consisting of two components as follows:

|     |   |
|-----|---|
| mat | A matrix where rows represent the time, columns are the samples, and the column names are the subjects. |
| cov | A two column matrix that contains the actigraphy data and clinical covariates.                          |

**Author(s)**

William D. Shannon, Tao Li, Hong Xian, Jia Wang, Elena Deych, Carlos Gonzalez

**Examples**

```
data(act_29pt)
data(clinic_29pt_ahi)

data <- act_29pt
ahi <- clinic_29pt_ahi

### Example 1: Continuous Covariate
matchida <- fda.matchid(data, ahi, "contin")

### Example 2: Categorical Covariate
ahi$ahicat <- as.factor(
  ifelse(ahi$AHI >= 0 & ahi$AHI <= 5, 1,
  ifelse(ahi$AHI > 5 & ahi$AHI <= 15, 2,
  ifelse(ahi$AHI > 15 & ahi$AHI <= 30, 3,
  ifelse(ahi$AHI > 30, 4, 0)))
)

matchidb <- fda.matchid(data, ahi[,-2], "factor",
  c("normal", "mild", "moderate", "severe"))
```

---

fda.smoothdata

*Functional Actigraphy Data Smoothing*


---

**Description**

This function produces functional actigraphy data from matrix actigraphy data.

**Usage**

```
fda.smoothdata(data, basistype="fourier", nbasis=9, norder=4)
```



**Arguments**

|           |  |
|-----------|--|
| data      | A list consisting of the following two components:<br>data\$mat A matrix where rows represent the time, columns are the samples, and the column names are the subjects.<br>data\$cov A two column matrix that contains the actigraphy data and clinical covariate. |
| basistype | A string specifying either "Fourier" and "bspline".  |
| nbasis    | The number of basis functions to be used for functional data. Default value is 9.  |
| norder    | The order of the bspline basis functions. Default value is 4.  |

**Details**

Note: The output of function `fda.matchid` can be directly used as the input for this argument. If the data is a categorical covariate

**Value**

A list consisting of two components as follows:

|     |  |
|-----|--|
| fd  | A <code>fdSmooth</code> data object containing the functional data (see function <code>smooth.basis</code> in the package <code>fda</code> for details). |
| cov | An object that is the same as the argument <code>data\$cov</code> .  |

**Author(s)**

William D. Shannon, Tao Li, Hong Xian, Jia Wang, Elena Deych, Carlos Gonzalez

**Examples**

```
data(act_29pt)
data(clinic_29pt_ahi)

data <- act_29pt
ahi <- clinic_29pt_ahi

matchid <- fda.matchid(data, ahi, "contin")
FDcont <- fda.smoothdata(matchid)

### Smooth the Results
ts.plot(predict(FDcont$fd$fd, 1:1440), main="Smoothed Activity Data")
```

flm\_cate

*Functional Linear Model Analysis***Description**

A function that does functional linear model analysis.

**Usage**

```
flm_cate(FD, basistype="fourier", nbasis=9, norder=4)
```

**Arguments**

|           |  |
|-----------|--|
| FD        | The list from the function <code>fda.smoothdata</code> .   |
| basistype | A string specifying either "fourier" and "bspline".  |
| nbasis    | The number of basis functions to be used for functional linear model analysis. Default value is 9.                         |
| norder    | an integer specifying the order of b-splines, which is one higher than their degree. The default of 4 gives cubic splines. |

**Value**

A list consisting of three components as follows:

|         |   |
|---------|---|
| freg    | A fRegress fit object containing the intercept and coefficient functions (check function <code>fRegress</code> for details) |
| fregstd | A list containing the standard error functions of the intercept and coefficient functions.                                  |

**Author(s)**

William D. Shannon, Tao Li, Hong Xian, Jia Wang, Elena Deych, Carlos Gonzalez

**Examples**

```
data(act_29pt)
data(clinic_29pt_ahi)

data <- act_29pt
ahi <- clinic_29pt_ahi

matchid <- fda.matchid(data, ahi, "contin")
FDcont <- fda.smoothdata(matchid)

geftFDcont <- flm_cate(FDcont)
```

---

weekday

*Data Set Containing Five Weekdays of Actigraph Data for One Subject*

---

**Description**

A data set containing five weekdays of actigraph data for one subject.

**Usage**

```
data(weekday)
```

**Format**

A data frame that consists of three columns; the first column is the weekday indices, the second column contains the indices of time in minutes from midnight to midnight, and the third contains the actigraph data.

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