Package 'bulletr'

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Title Algorithms for Matching Bullet Lands

Version 0.1

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Description Analyze bullet lands using nonparametric methods. We provide a reading routine for x3p files (see <http://www.openfmc.org> for more information) and a host of analysis functions designed to assess the probability that two bullets were fired from the same gun barrel.

URL https://github.com/erichare/bulletr

BugReports https://github.com/erichare/bulletr/issues

Imports xml2, zoo, ggplot2, plyr, dplyr, reshape2, plotly, robustbase, smoother

Depends R (>= 3.1)

RoxygenNote 6.0.1

LazyData true

NeedsCompilation no

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Repository CRAN

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R topics documented:

`boot_fit_loess` *Fit a LOESS model with bootstrap samples*

Description

Fit a LOESS model with bootstrap samples

Usage

```
boot_fit_loess(bullet, groove, B = 1000, alpha = 0.95)
```

Arguments

`bullet`	Bullet as returned from fortify_x3p
`groove`	Groove as returned from get_grooves
`B`	number of Bootstrap samples
`alpha`	The significance level

br411 — *3d topological surface measurements for one land of a bullet from the Hamby study*

Description

Some more info - not sure at the moment which bullet this is. Describe structure.

Usage

```
br411
```

Format

a list

bulletAlign — *Align two surface cross cuts according to maximal correlation*

Description

The bullet with the first name serves as a reference, the second bullet is shifted.

Usage

```
bulletAlign(data, value = "l30")
```

Arguments

data	data frame consisting of at least two surface crosscuts as given by function bulletSmooth.
value	string of the variable to match. Defaults to l30, the variable returned from function bulletSmooth.

Value

list consisting of a) the maximal cross correlation, b) the lag resulting in the highest cross correlation, and c) same data frame as input, but y vectors are aligned for maximal correlation between the

bulletCheckCrossCut *Identifying a reliable cross section*

Description

Should be changed: x should just indicate lower and upper limit. That is cleaner and should speed things up as well.

Usage

```
bulletCheckCrossCut(path, bullet = NULL, distance = 25, xlimits = c(50,
  500), minccf = 0.9, span = 0.03)
```

Arguments

path	path to an x3p file
bullet	If passed in, the actual bullet already loaded
distance	positive numeric value indicating the distance between cross sections to use for a comparison
xlimits	vector of values between which to check for cross sections in a stable region
minccf	minimal value of cross correlation to indicate a stable region
span	The span for the loess smooth function

bulletGetMaxCMS *Identify the number of maximum CMS between two bullet lands*

Description

Identify the number of maximum CMS between two bullet lands

Usage

```
bulletGetMaxCMS(lof1, lof2, column = "resid", span = 35)
```

Arguments

lof1	dataframe of smoothed first signature
lof2	dataframe of smoothed second signature
column	The column which to smooth
span	positive number for the smoothfactor to use for assessing peaks.

Value

list of matching parameters, data set of the identified striae, and the aligned data sets.

bulletGetMaxCMS_nist *Identify the number of maximum CMS between two bullet lands*

Description

Identify the number of maximum CMS between two bullet lands

Usage

```
bulletGetMaxCMS_nist(lof1, lof2, column = "resid", span = 35)
```

Arguments

lof1	dataframe of smoothed first signature
lof2	dataframe of smoothed second signature
column	The column which to smooth
span	positive number for the smoothfactor to use for assessing peaks.

Value

list of matching parameters, data set of the identified striae, and the aligned data sets.

bulletSmooth *Smooth the surface of a bullet*

Description

Smooth the surface of a bullet

Usage

```
bulletSmooth(data, span = 0.03, limits = c(-5, 5))
```

Arguments

data	data frame as returned by the function processBullets
span	width of the smoother, defaults to 0.03
limits	vector of the form c(min, max). Results will be limited to be between these values.

Value

data frame of the same form as the input extended by the vector l30 for the smooth.

CMS *Table of the number of consecutive matches*

Description

Table of the number of consecutive matches

Usage

```
CMS(match)
```

Arguments

match	is a Boolean vector of matches/non-matches

Value

a table of the number of the CMS and their frequencies

Examples

```
x <- rbinom(100, size = 1, prob = 1/3)
CMS(x == 1) # expected value for longest match is 3
```

fit_loess *Fit a loess curve to a bullet data frame*

Description

First, the surface measurements of the bullet land is trimmed to be within left and right groove as specified by vector groove. A loess regression is fit to the remaining surface measurements and residuals are calculated. The most extreme 0.25 The result is called the signature of the bullet land.

Usage

```
fit_loess(bullet, groove, span = 0.75)
```

Arguments

bullet	The bullet object as returned from fortify_x3p
groove	vector of two numeric values indicating the location of the left and right groove.
span	The span to use for the loess regression

Value

a list of a data frame of the original bullet measurements extended by loess fit, residuals, and standard errors and two plots: a plot of the fit, and a plot of the bullet's land signature.

fortify_x3p *Convert a list of x3p file into a data frame*

Description

x3p format consists of a list with header info and a 2d matrix of scan depths. fortify_x3p turn the matrix into a variable within a data frame, using the parameters of the header as necessary.

Usage

```
fortify_x3p(x3p)
```

Arguments

x3p	a file in x3p format as return by function read_x3p

Value

data frame with variables x, y, and value

Examples

```
data(br411)
br411_fort <- fortify_x3p(br411)
head(br411_fort)
```

getCircle *Estimate center and radius*

Description

Assuming the variables x and y are describing points located on a circle, the function uses a likelihood approach to estimate center and radius of the circle.

Usage

```
getCircle(x, y)
```

Arguments

x	numeric vector of values
y	numeric vector of values

Value

three dimensional vector of the circle center (x0, y0) and the radius

getTwist *Estimate the twist in a bullet land*

Description

Estimation of the twist in a barrel follows roughly the process described by Chu et al (2010). At the moment, twist is estimated from a single land - but the twist should be the same for the whole barrel. Therefore all lands of the same barrel should have the same twist. A note on timing: at the moment calculating the twist rate for a bullet land takes several minutes. XXX TODO XXX make the different methods a parameter. Also, accept other input than the path - if we start with the flattened bulletland we get results much faster.

Usage

```
getTwist(path, bullet = NULL, twistlimit = NULL, cutoff = 0.75)
```

Arguments

path	to a file in x3p format
bullet	data in x3p format as returned by function read_x3p
twistlimit	Constraint the possible twist value
cutoff	Use this for the quantile cutoff

Value

numeric value estimating the twist

Examples

```
## Not run:
# execution takes several minutes
load("data/b1.rda")
twist <- getTwist(path="barrel 1 bullet 1", bullet = b1, twistlimit=c(-2,0)*1.5625)

## End(Not run)
```

get_bullet *Deprecated function use get_crosscut*

Description

Deprecated function use get_crosscut

Usage

```
get_bullet(path, x = 243.75)
```

Arguments

path	The path to the x3p file
x	The crosscut value

---

get_crosscut *Read a crosscut from a 3d surface file*

Description

Read a crosscut from a 3d surface file

Usage

```
get_crosscut(path = NULL, x = 243.75, bullet = NULL)
```

Arguments

path	path to an x3p file. The path will only be considered, if bullet is not specified.
x	level of the crosscut to be taken. If this level does not exist, the crosscut with the closest level is returned.
bullet	alternative access to the surface measurements.

Value

data frame

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get_grooves *Find the grooves of a bullet land*

Description

Find the grooves of a bullet land

Usage

```
get_grooves(bullet, smoothfactor = 15, adjust = 10, groove_cutoff = 400,
  mean_left = NULL, mean_right = NULL, mean_window = 100)
```

Arguments

bullet	data frame with topological data
smoothfactor	The smoothing window to use
adjust	positive number to adjust the grooves
groove_cutoff	The index at which a groove cannot exist past
mean_left	If provided, the location of the average left groove
mean_right	If provided, the location of the average right groove
mean_window	The window around the means to use

---

get_peaks *Identify the location and the depth of peaks and heights at a crosscut*

Description

Identify the location and the depth of peaks and heights at a crosscut

Usage

```
get_peaks(loessdata, column = "resid", smoothfactor = 35, striae = TRUE,
  window = TRUE)
```

Arguments

loessdata	export from rollapply
column	The column which should be smoothed
smoothfactor	set to default of 35. Smaller values will pick up on smaller changes in the crosscut.
striae	If TRUE, show the detected striae on the plot
window	If TRUE, show the window of the striae on the plot

Value

list of several objects:

get_peaks_nist *Identify the location and the depth of peaks and heights at a crosscut*

Description

Identify the location and the depth of peaks and heights at a crosscut

Usage

```
get_peaks_nist(loessdata, column = "resid", smoothfactor = 35,
  striae = TRUE, window = TRUE)
```

Arguments

loessdata	export from rollapply
column	The column which should be smoothed
smoothfactor	set to default of 35. Smaller values will pick up on smaller changes in the cross-cut.
striae	If TRUE, show the detected striae on the plot
window	If TRUE, show the window of the striae on the plot

Value

list of several objects:

maxCMS *Number of maximum consecutively matching striae*

Description

Number of maximum consecutively matching striae

Usage

```
maxCMS(match)
```

Arguments

match	is a Boolean vector of matches/non-matches

Value

an integer value of the maximum number of consecutive matches

Examples

```
x <- rbinom(100, size = 1, prob = 1/3)
CMS(x == 1) # expected value for longest match is 3
maxCMS(x==1)
```

`plot_3d_land` *Plot a bullet land using plotly*

Description

Plot a bullet land using plotly

Usage

```
plot_3d_land(path, bullet = NULL)
```

Arguments

`path`	The path to the x3p file
`bullet`	If not null, use this pre-loaded bullet

`predCircle` *Estimate predictions and residuals for a circle fit of x and y*

Description

estimate a circle, find predictive values and resiudals. depending on specification, vertical (regular) residuals or orthogonal residuals are computed.

Usage

```
predCircle(x, y, resid.method = "response")
```

Arguments

`x`	vector of numeric values
`y`	vector of numeric values
`resid.method`	character, one of "response" or "ortho"(gonal)

Value

data frame with predictions and residuals

predSmooth *Estimate predictions and residuals for a smooth of x and y*

Description

Fit a smooth line throught x and y, find predictive values and resiudals.

Usage

```
predSmooth(x, y)
```

Arguments

x	vector of numeric values
y	vector of numeric values

Value

data frame with predictions and residuals

processBullets *Process x3p file*

Description

x3p file of a 3d topological bullet surface is processed at surface crosscut x, the bullet grooves in the crosscuts are identified and removed, and a loess smooth is used (see `?loess` for details) to remove the big structure.

Usage

```
processBullets(bullet, name = "", x = 100, grooves = NULL, span = 0.75,
  window = 0, ...)
```

Arguments

bullet	file as returned from read_x3p
name	name of the bullet
x	(vector) of surface crosscuts to process.
grooves	The grooves to use as a two element vector, if desired
span	The span for the loess fit
window	The mean window around the ideal crosscut
...	Additional arguments, passed to the get_grooves function

Value

data frame

Examples

```
data(br411)
br411_processed <- processBullets(br411, name = "br411")
```

`read_x3p` *Read an x3p file as an R Data Frame*

Description

Read an x3p file as an R Data Frame

Usage

```
read_x3p(path, profiley = TRUE)
```

Arguments

`path`	The file path to the x3p file
`profiley`	If TRUE, rotate the matrix (if necessary) to ensure a profile is taken across y

Examples

```
## Not run:
br411 <- read_x3p("Br4 Bullet 4-1.x3p")

## End(Not run)
```

`sample_x3p` *Sample every X element of a data frame*

Description

Sample every X element of a data frame in x and y direction

Usage

```
sample_x3p(dframe, byxy = c(2, 2))
```

Arguments

dframe	data frame with x and y variable
byxy	(vector) of numeric value indicating the sapling resolution. If a single number, the same resolution is used for x and y.

Value

subset of the input variable

Examples

```
data(br411)
br411_fort <- fortify_x3p(br411)
br411_sample <- sample_x3p(br411_fort, byxy = c(4, 4))
head(br411_sample)
```

---

smoothloess *Predict smooth from a fit*

Description

Predict smooth from a fit

Usage

```
smoothloess(x, y, span, sub = 2)
```

Arguments

x	X values to use
y	Y values to use
span	The span of the loess fit
sub	Subsample factor

striation_identify *Match striation marks across two cross sections based on previously identified peaks and valleys*

Description

Match striation marks across two cross sections based on previously identified peaks and valleys

Usage

```
striation_identify(lines1, lines2)
```

Arguments

lines1	data frame as returned from get_peaks function. data frames are expected to have the following variables: xmin, xmax, group, type, bullet, heights
lines2	data frame as returned from get_peaks function. data frames are expected to have the following variables: xmin, xmax, group, type, bullet, heights

Value

data frame of the same form as lines1 and lines2, but consisting of an additional variable of whether the striation marks are matches

unfortify_x3p *Convert a data frame into an x3p file*

Description

Convert a data frame into an x3p file

Usage

```
unfortify_x3p(df)
```

Arguments

df	A data frame produced by fortify_x3p

Value

An x3p object

Examples

```
data(br411)
br411_fort <- fortify_x3p(br411)
br411_unfort <- unfortify_x3p(br411_fort)
identical(br411_unfort, br411)
```

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