

Package ‘diveMove’

February 23, 2017

Type Package

Title Dive Analysis and Calibration

Version 1.4.2

Depends R (>= 2.13.0), methods, stats4

Suggests knitr, lattice, tcltk

Imports caTools, KernSmooth, quantreg, uniReg, geosphere

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Description Utilities to represent, visualize, filter, analyse, and summarize time-depth recorder (TDR) data. Miscellaneous functions for handling location data are also provided.

LazyLoad yes

LazyData no

ZipData no

BuildResaveData no

VignetteBuilder knitr

Collate AllClass.R AllGenerics.R AllMethod.R austFilter.R bouts.R
calibrate.R detDive.R detPhase.R distSpeed.R diveStats.R
oneDiveStats.R plotTDR.R plotZOC.R readLocs.R readTDR.R
speedStats.R stampDive.R zoc.R zzz.R

License GPL-3

URL <https://github.com/spluque/diveMove>

NeedsCompilation no

Repository CRAN

Date/Publication 2017-02-23 08:31:10

R topics documented:

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diveMove-package *Dive Analysis and Calibration*

Description

This package is a collection of functions for visualizing, and analyzing depth and speed data from time-depth recorders TDRs. These can be used to zero-offset correct depth, calibrate speed, and divide the record into different phases, or time budget. Functions are provided for calculating summary dive statistics for the whole record, or at smaller scales within dives.

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See Also

A vignette with a guide to this package is available by doing `vignette("diveMove")`. [TDR-class](#), [calibrateDepth](#), [calibrateSpeed](#), [timeBudget](#), [stampDive](#).

Examples

```

## Too long for checks
## read in data and create a TDR object
zz <- system.file(file.path("data", "dives.csv"),
                  package="diveMove", mustWork=TRUE)
(sealX <- readTDR(zz, speed=TRUE, sep=";", na.strings="", as.is=TRUE))

if (dev.interactive(orNone=TRUE)) plotTDR(sealX) # interactively pan and zoom

## detect periods of activity, and calibrate depth, creating
## a "TDRcalibrate" object
if (dev.interactive(orNone=TRUE)) dcalib <- calibrateDepth(sealX)
## Use the "offset" ZOC method to zero-offset correct depth at 3 m
(dcalib <- calibrateDepth(sealX, zoc.method="offset", offset=3))

if (dev.interactive(orNone=TRUE)) {
  ## plot all readings and label them with the phase of the record
  ## they belong to, excluding surface readings
  plotTDR(dcalib, surface=FALSE)
  ## plot the first 300 dives, showing dive phases and surface readings
  plotTDR(dcalib, diveNo=seq(300), surface=TRUE)
}

## calibrate speed (using changes in depth > 1 m and default remaining arguments)
(vcalib <- calibrateSpeed(dcalib, z=1))

## Obtain dive statistics for all dives detected
dives <- diveStats(vcalib)
head(dives)

## Attendance table
att <- timeBudget(vcalib, FALSE) # taking trivial aquatic activities into account
att <- timeBudget(vcalib, TRUE) # ignoring them
## Identify which phase each dive belongs to
stamps <- stampDive(vcalib)
sumtab <- data.frame(stamps, dives)
head(sumtab)

```

austFilter

Filter satellite locations

Description

Apply a three stage algorithm to eliminate erroneous locations, based on the procedure outlined in Austin et al. (2003).

Usage

```

austFilter(time, lon, lat, id=gl(1, 1, length(time)),
           speed.thr, dist.thr, window=5, ...)
grpSpeedFilter(x, speed.thr, window=5, ...)
rmsDistFilter(x, speed.thr, window=5, dist.thr, ...)

```

Arguments

| | |
|-----------|---|
| time | POSIXct object with dates and times for each point. |
| lon | numeric vectors of longitudes, in decimal degrees. |
| lat | numeric vector of latitudes, in decimal degrees. |
| id | A factor grouping points in different categories (e.g. individuals). |
| speed.thr | numeric scalar: speed threshold (m/s) above which filter tests should fail any given point. |
| dist.thr | numeric scalar: distance threshold (km) above which the last filter test should fail any given point. |
| window | integer: the size of the moving window over which tests should be carried out. |
| x | 3-column matrix with column 1: POSIXct vector; column 2: numeric longitude vector; column 3: numeric latitude vector. |
| ... | Arguments ultimately passed to distSpeed . |

Details

These functions implement the location filtering procedure outlined in Austin et al. (2003). `grpSpeedFilter` and `rmsDistFilter` can be used to perform only the first stage or the second and third stages of the algorithm on their own, respectively. Alternatively, the three filters can be run in a single call using `austFilter`.

The first stage of the filter is an iterative process which tests every point, except the first and last $(w/2) - 1$ (where w is the window size) points, for travel velocity relative to the preceding/following $(w/2) - 1$ points. If all $w - 1$ speeds are greater than the specified threshold, the point is marked as failing the first stage. In this case, the next point is tested, removing the failing point from the set of test points.

The second stage runs McConnell et al. (1992) algorithm, which tests all the points that passed the first stage, in the same manner as above. The root mean square of all $w - 1$ speeds is calculated, and if it is greater than the specified threshold, the point is marked as failing the second stage (see Warning section below).

The third stage is run simultaneously with the second stage, but if the mean distance of all $w - 1$ pairs of points is greater than the specified threshold, then the point is marked as failing the third stage.

The speed and distance threshold should be obtained separately (see [distSpeed](#)).

Value

grpSpeedFilter returns a logical vector indicating those lines that passed the test.

rmsDistFilter and austFilter return a matrix with 2 or 3 columns, respectively, of logical vectors with values TRUE for points that passed each stage. For the latter, positions that fail the first stage fail the other stages too. The second and third columns returned by austFilter, as well as those returned by rmsDistFilter are independent of one another; i.e. positions that fail stage 2 do not necessarily fail stage 3.

Warning

This function applies McConnell et al.'s filter as described in Freitas et al. (2008). According to the original description of the algorithm in McConnell et al. (1992), the filter makes a single pass through all locations. Austin et al. (2003) and other authors may have used the filter this way. However, as Freitas et al. (2008) noted, this causes locations adjacent to those flagged as failing to fail also, thereby rejecting too many locations. In diveMove, the algorithm was modified to reject only the "peaks" in each series of consecutive locations having root mean square speed higher than threshold.

Author(s)

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References

- McConnell BJ, Chambers C, Fedak MA. 1992. Foraging ecology of southern elephant seals in relation to bathymetry and productivity of the Southern Ocean. *Antarctic Science* 4:393-398.
- Austin D, McMillan JI, Bowen D. 2003. A three-stage algorithm for filtering erroneous Argos satellite locations. *Marine Mammal Science* 19: 371-383.
- Freitas C, Lydersen, C, Fedak MA, Kovacs KM. 2008. A simple new algorithm to filter marine mammal ARGOS locations. *Marine Mammal Science* DOI: 10.1111/j.1748-7692.2007.00180.x

See Also

[distSpeed](#)

Examples

```
## Using the Example from '?readLocs':
utils::example("readLocs", package="diveMove",
              ask=FALSE, echo=FALSE)
ringy <- subset(locs, id == "ringy" & !is.na(lon) & !is.na(lat))

## Examples below use default Meeus algorithm for computing distances.
## See ?distSpeed for specifying other methods.
## Austin et al.'s group filter alone
grp <- grpSpeedFilter(ringy[, 3:5], speed.thr=1.1)

## McConnell et al.'s filter (root mean square test), and distance test alone
```

```

rms <- rmsDistFilter(ringy[, 3:5], speed.thr=1.1, dist.thr=300)

## Show resulting tracks
n <- nrow(ringy)
plot.nofilter <- function(main) {
  plot(lat ~ lon, ringy, type="n", main=main)
  with(ringy, segments(lon[-n], lat[-n], lon[-1], lat[-1]))
}
layout(matrix(1:4, ncol=2, byrow=TRUE))
plot.nofilter(main="Unfiltered Track")
plot.nofilter(main="Group Filter")
n1 <- length(which(grp))
with(ringy[grp, ], segments(lon[-n1], lat[-n1], lon[-1], lat[-1],
                           col="blue"))
plot.nofilter(main="Root Mean Square Filter")
n2 <- length(which(rms[, 1]))
with(ringy[rms[, 1], ], segments(lon[-n2], lat[-n2], lon[-1], lat[-1],
                                col="red"))
plot.nofilter(main="Distance Filter")
n3 <- length(which(rms[, 2]))
with(ringy[rms[, 2], ], segments(lon[-n3], lat[-n3], lon[-1], lat[-1],
                                col="green"))

## All three tests (Austin et al. procedure)
austin <- with(ringy, austFilter(time, lon, lat, speed.thr=1.1,
                               dist.thr=300))
layout(matrix(1:4, ncol=2, byrow=TRUE))
plot.nofilter(main="Unfiltered Track")
plot.nofilter(main="Stage 1")
n1 <- length(which(austin[, 1]))
with(ringy[austin[, 1], ], segments(lon[-n1], lat[-n1], lon[-1], lat[-1],
                                   col="blue"))
plot.nofilter(main="Stage 2")
n2 <- length(which(austin[, 2]))
with(ringy[austin[, 2], ], segments(lon[-n2], lat[-n2], lon[-1], lat[-1],
                                   col="red"))
plot.nofilter(main="Stage 3")
n3 <- length(which(austin[, 3]))
with(ringy[austin[, 3], ], segments(lon[-n3], lat[-n3], lon[-1], lat[-1],
                                   col="green"))

```

Description

Plot results from fitted mixture of 2-process Poisson models, and calculate the bout ending criterion.

Usage

```
## S4 method for signature 'nls'  
plotBouts(fit, ...)  
## S4 method for signature 'mle'  
plotBouts(fit, x, ...)  
## S4 method for signature 'nls'  
bec2(fit)  
## S4 method for signature 'mle'  
bec2(fit)  
## S4 method for signature 'nls'  
bec3(fit)
```

Arguments

| | |
|------------------|--|
| <code>fit</code> | <code>nls</code> or <code>mle</code> object. |
| <code>x</code> | numeric object with variable modelled. |
| <code>...</code> | Arguments passed to the underlying <code>plotBouts2.nls</code> and <code>plotBouts2.mle</code> . |

General Methods

plotBouts signature(`fit="nls"`): Plot fitted 2- or 3-process model of log frequency vs the interval mid points, including observed data.

plotBouts signature(`x="mle"`): As the `nls` method, but models fitted through maximum likelihood method. This plots the fitted model and a density plot of observed data.

bec2 signature(`fit="nls"`): Extract the estimated bout ending criterion from a fitted 2-process model.

bec2 signature(`fit="mle"`): As the `nls` method, but extracts the value from a maximum likelihood model.

bec3 signature(`fit="nls"`): Extract the estimated bout ending criterion from a fitted 3-process model.

Author(s)

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References

- Berdoy, M. (1993) Defining bouts of behaviour: a three-process model. *Animal Behaviour* **46**, 387-396.
- Langton, S.; Collett, D. and Sibly, R. (1995) Splitting behaviour into bouts; a maximum likelihood approach. *Behaviour* **132**, 9-10.
- Luque, S. P. and Guinet, C. (2007) A maximum likelihood approach for identifying dive bouts improves accuracy, precision, and objectivity. *Behaviour* **144**, 1315-1332.
- Mori, Y.; Yoda, K. and Sato, K. (2001) Defining dive bouts using a sequential differences analysis. *Behaviour* **138**, 1451-1466.
- Sibly, R.; Nott, H. and Fletcher, D. (1990) Splitting behaviour into bouts. *Animal Behaviour* **39**, 63-69.

See Also

[bouts.mle](#), [bouts2.nls](#), [bouts3.nls](#) for examples.

| | |
|-----------|--|
| bout-misc | <i>Fit a Broken Stick Model on Log Frequency Data for identification of bouts of behaviour</i> |
|-----------|--|

Description

Application of methods described by Sibly et al. (1990) and Mori et al. (2001) for the identification of bouts of behaviour.

Usage

```
boutfreqs(x, bw, method=c("standard", "seq.diff"), plot=TRUE, ...)
boutinit(lnfreq, x.break, plot=TRUE, ...)
labelBouts(x, bec, bec.method=c("standard", "seq.diff"))
logit(p)
unLogit(logit)
```

Arguments

| | |
|--------------------|---|
| x | numeric vector on which bouts will be identified based on “method”. For labelBouts it can also be a matrix with different variables for which bouts should be identified. |
| bw | numeric scalar: bin width for the histogram. |
| method, bec.method | character: method used for calculating the frequencies: “standard” simply uses x, while “seq.diff” uses the sequential differences method. |
| plot | logical, whether to plot results or not. |
| ... | For boutfreqs, arguments passed to hist (must exclude breaks and include.lowest); for boutinit, arguments passed to plot (must exclude type). |
| lnfreq | data.frame with components <i>lnfreq</i> (log frequencies) and corresponding x (mid points of histogram bins). |
| x.break | vector of length 1 or 2 with x value(s) defining the break(s) point(s) for broken stick model, such that $x < x.break[1]$ is 1st process, and $x \geq x.break[1] \& x < x.break[2]$ is 2nd one, and $x \geq x.break[2]$ is 3rd one. |
| bec | numeric vector or matrix with values for the bout ending criterion which should be compared against the values in x for identifying the bouts. |
| p | numeric vector of proportions (0-1) to transform to the logit scale. |
| logit | numeric scalar: logit value to transform back to original scale. |

Details

This follows the procedure described in Mori et al. (2001), which is based on Sibly et al. 1990. Currently, only a two process model is supported.

`boutfreqs` creates a histogram with the log transformed frequencies of x with a chosen bin width and upper limit. Bins following empty ones have their frequencies averaged over the number of previous empty bins plus one.

`boutinit` fits a "broken stick" model to the log frequencies modelled as a function of x (well, the midpoints of the binned data), using chosen value(s) to separate the two or three processes.

`labelBouts` labels each element (or row, if a matrix) of x with a sequential number, identifying which bout the reading belongs to. The `bec` argument needs to have the same dimensions as x to allow for situations where `bec` within x .

`logit` and `unLogit` are useful for reparameterizing the negative maximum likelihood function, if using Langton et al. (1995).

Value

`boutfreqs` returns a data frame with components *Infreq* containing the log frequencies and x , containing the corresponding mid points of the histogram. Empty bins are excluded. A plot (histogram of *input data*) is produced as a side effect if argument `plot` is TRUE. See the Details section.

`boutinit` returns a list with as many elements as the number of processes implied by `x.break` (i.e. `length(x.break) + 1`). Each element is a vector of length two, corresponding to a and λ , which are starting values derived from broken stick model. A plot is produced as a side effect if argument `plot` is TRUE.

`labelBouts` returns a numeric vector sequentially labelling each row or element of x , which associates it with a particular bout.

`unLogit` and `logit` return a numeric vector with the (un)transformed arguments.

Author(s)

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References

Langton, S.; Collett, D. and Sibly, R. (1995) Splitting behaviour into bouts; a maximum likelihood approach. *Behaviour* **132**, 9-10.

Luque, S.P. and Guinet, C. (2007) A maximum likelihood approach for identifying dive bouts improves accuracy, precision, and objectivity. *Behaviour*, **144**, 1315-1332.

Mori, Y.; Yoda, K. and Sato, K. (2001) Defining dive bouts using a sequential differences analysis. *Behaviour*, 2001 **138**, 1451-1466.

Sibly, R.; Nott, H. and Fletcher, D. (1990) Splitting behaviour into bouts. *Animal Behaviour* **39**, 63-69.

See Also

[bouts2.nls](#), [bouts.mle](#). These include an example for `labelBouts`.

Examples

```
## Too long for checks
## Using the Example from '?diveStats':
utils::example("diveStats", package="diveMove",
              ask=FALSE, echo=FALSE)
postdives <- tdrX.tab$postdive.dur[tdrX.tab$phase.no == 2]
## Remove isolated dives
postdives <- postdives[postdives < 2000]
lnfreq <- boutfreqs(postdives, bw=0.1, method="seq.diff", plot=FALSE)
boutinit(lnfreq, 50)

## See ?bouts.mle for labelBouts() example
```

bouts2MLE

Maximum Likelihood Model of mixture of 2 Poisson Processes

Description

Functions to model a mixture of 2 random Poisson processes to identify bouts of behaviour. This follows Langton et al. (1995).

Usage

```
bouts2.mleFUN(x, p, lambda1, lambda2)
bouts2.ll(x)
bouts2.LL(x)
bouts.mle(ll.fun, start, x, ...)
bouts2.mleBEC(fit)
plotBouts2.mle(fit, x, xlab="x", ylab="Log Frequency", bec.lty=2, ...)
plotBouts2.cdf(fit, x, draw.bec=FALSE, bec.lty=2, ...)
```

Arguments

| | |
|---------------------|--|
| x | numeric vector with values to model. |
| p, lambda1, lambda2 | numeric: parameters of the mixture of Poisson processes. |
| ll.fun | function returning the negative of the maximum likelihood function that should be maximized. This should be a valid <code>minuslogl</code> argument to <code>mle</code> . |
| start, ... | Arguments passed to <code>mle</code> . For <code>plotBouts2.cdf</code> , arguments passed to <code>plot.ecdf</code> . For <code>plotBouts2.mle</code> , arguments passed to <code>curve</code> (must exclude <code>xaxis</code> , <code>yaxis</code>). For <code>plotBouts2.nls</code> , arguments passed to <code>plot</code> (must exclude type). |
| fit | <code>mle</code> object. |
| xlab, ylab | character: titles for the x and y axes. |

| | |
|-----------------------|---|
| <code>bec.lty</code> | Line type specification for drawing the BEC reference line. |
| <code>draw.bec</code> | logical; do we draw the BEC? |

Details

For now only a mixture of 2 Poisson processes is supported. Even in this relatively simple case, it is very important to provide good starting values for the parameters.

One useful strategy to get good starting parameter values is to proceed in 4 steps. First, fit a broken stick model to the log frequencies of binned data (see `boutinit`), to obtain estimates of 4 parameters corresponding to a 2-process model (Sibly et al. 1990). Second, calculate parameter p from the 2 alpha parameters obtained from the broken stick model, to get 3 tentative initial values for the 2-process model from Langton et al. (1995). Third, obtain MLE estimates for these 3 parameters, but using a reparameterized version of the -log L2 function. Lastly, obtain the final MLE estimates for the 3 parameters by using the estimates from step 3, un-transformed back to their original scales, maximizing the original parameterization of the -log L2 function.

`boutinit` can be used to perform step 1. Calculation of the mixing parameter p in step 2 is trivial from these estimates. Function `bouts2.LL` is a reparameterized version of the -log L2 function given by Langton et al. (1995), so can be used for step 3. This uses a logit (see `logit`) transformation of the mixing parameter p , and log transformations for both density parameters λ_{d1} and λ_{d2} . Function `bouts2.ll` is the -log L2 function corresponding to the un-transformed model, hence can be used for step 4.

`bouts.mle` is the function performing the main job of maximizing the -log L2 functions, and is essentially a wrapper around `mle`. It only takes the -log L2 function, a list of starting values, and the variable to be modelled, all of which are passed to `mle` for optimization. Additionally, any other arguments are also passed to `mle`, hence great control is provided for fitting any of the -log L2 functions.

In practice, step 3 does not pose major problems using the reparameterized -log L2 function, but it might be useful to use method “L-BFGS-B” with appropriate lower and upper bounds. Step 4 can be a bit more problematic, because the parameters are usually on very different scales. Therefore, it is almost always the rule to use method “L-BFGS-B”, again bounding the parameter search, as well as passing a control list with proper `parscale` for controlling the optimization. See Note below for useful constraints which can be tried.

Value

`bouts.mle` returns an object of class `mle`.

`bouts2.mleBEC` and `bouts2.mleFUN` return a numeric vector.

`bouts2.LL` and `bouts2.ll` return a function.

`plotBouts2.mle` and `plotBouts2.cdf` return nothing, but produce a plot as side effect.

Note

In the case of a mixture of 2 Poisson processes, useful values for lower bounds for the `bouts.LL` reparameterization are `c(-2, -5, -10)`. For `bouts2.ll`, useful lower bounds are `rep(1e-08, 3)`. A useful `parscale` argument for the latter is `c(1, 0.1, 0.01)`. However, I have only tested this for cases of diving behaviour in pinnipeds, so these suggested values may not be useful in other cases.

The lambdas can be very small for some data, particularly `lambda2`, so the default `ndeps` in `optim` can be so large as to push the search outside the bounds given. To avoid this problem, provide a smaller `ndeps` value.

Author(s)

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References

Langton, S.; Collett, D. and Sibly, R. (1995) Splitting behaviour into bouts; a maximum likelihood approach. *Behaviour* **132**, 9-10.

Luque, S.P. and Guinet, C. (2007) A maximum likelihood approach for identifying dive bouts improves accuracy, precision, and objectivity. *Behaviour*, **144**, 1315-1332.

Sibly, R.; Nott, H. and Fletcher, D. (1990) Splitting behaviour into bouts. *Animal Behaviour* **39**, 63-69.

See Also

[mle](#), [optim](#), [logit](#), [unLogit](#) for transforming and fitting a reparameterized model.

Examples

```
## Too long for checks
## Using the Example from '?diveStats':
utils::example("diveStats", package="diveMove",
              ask=FALSE, echo=FALSE)
postdives <- tdrX.tab$postdive.dur[tdrX.tab$phase.no == 2]
postdives.diff <- abs(diff(postdives))

## Remove isolated dives
postdives.diff <- postdives.diff[postdives.diff < 2000]
lnfreq <- boutfreqs(postdives.diff, bw=0.1, plot=FALSE)
startval <- boutinit(lnfreq, 50)
p <- startval[[1]]["a"] / (startval[[1]]["a"] + startval[[2]]["a"])

## Fit the reparameterized (transformed parameters) model
## Drop names by wrapping around as.vector()
init.parms <- list(p=as.vector(logit(p)),
                  lambda1=as.vector(log(startval[[1]]["lambda"])),
                  lambda2=as.vector(log(startval[[2]]["lambda"])))
bout.fit1 <- bouts.mle(bouts2.LL, start=init.parms, x=postdives.diff,
                     method="L-BFGS-B", lower=c(-2, -5, -10))
coefs <- as.vector(coef(bout.fit1))

## Un-transform and fit the original parameterization
init.parms <- list(p=unLogit(coefs[1]), lambda1=exp(coefs[2]),
                  lambda2=exp(coefs[3]))
bout.fit2 <- bouts.mle(bouts2.ll, x=postdives.diff, start=init.parms,
                     method="L-BFGS-B", lower=rep(1e-08, 3),
```

```

                                control=list(parscale=c(1, 0.1, 0.01)))
plotBouts(bout.fit2, postdives.diff)

## Plot cumulative frequency distribution
plotBouts2.cdf(bout.fit2, postdives.diff)

## Estimated BEC
bec <- bec2(bout.fit2)

## Label bouts
labelBouts(postdives, rep(bec, length(postdives)),
           bec.method="seq.diff")

```

bouts2NLS

Fit mixture of 2 Poisson Processes to Log Frequency data

Description

Functions to model a mixture of 2 random Poisson processes to histogram-like data of log frequency vs interval mid points. This follows Sibly et al. (1990) method.

Usage

```

bouts2.nlsFUN(x, a1, lambda1, a2, lambda2)
bouts2.nls(lnfreq, start, maxiter)
bouts2.nlsBEC(fit)
plotBouts2.nls(fit, lnfreq, bec.lty, ...)

```

Arguments

| | |
|---------------------------------------|---|
| <code>x</code> | numeric vector with values to model. |
| <code>a1, lambda1, a2, lambda2</code> | numeric: parameters from the mixture of Poisson processes. |
| <code>lnfreq</code> | data.frame with named components <i>lnfreq</i> (log frequencies) and corresponding <code>x</code> (mid points of histogram bins). |
| <code>start, maxiter</code> | Arguments passed to nls . |
| <code>fit</code> | nls object. |
| <code>bec.lty</code> | Line type specification for drawing the BEC reference line. |
| <code>...</code> | Arguments passed to plot.default . |

Details

bouts2.nlsFUN is the function object defining the nonlinear least-squares relationship in the model. It is not meant to be used directly, but is used internally by bouts2.nls.

bouts2.nls fits the nonlinear least-squares model itself.

bouts2.nlsBEC calculates the BEC from a list object, as the one that is returned by [nls](#), representing a fit of the model. plotBouts2.nls plots such an object.

Value

bouts2.nlsFUN returns a numeric vector evaluating the mixture of 2 Poisson process.

bouts2.nls returns an nls object resulting from fitting this model to data.

bouts2.nlsBEC returns a number corresponding to the bout ending criterion derived from the model.

plotBouts2.nls plots the fitted model with the corresponding data.

Author(s)

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References

Sibly, R.; Nott, H. and Fletcher, D. (1990) Splitting behaviour into bouts *Animal Behaviour* **39**, 63-69.

See Also

[bouts.mle](#) for a better approach; [boutfreqs](#); [boutinit](#)

Examples

```
## Too long for checks
## Using the Example from '?diveStats':
utils::example("diveStats", package="diveMove",
              ask=FALSE, echo=FALSE)
## Postdive durations
postdives <- tdrX.tab$postdive.dur[tdrX.tab$phase.no == 2]
postdives.diff <- abs(diff(postdives))
## Remove isolated dives
postdives.diff <- postdives.diff[postdives.diff < 2000]

## Construct histogram
lnfreq <- boutfreqs(postdives.diff, bw=0.1, plot=FALSE)

startval <- boutinit(lnfreq, 50)
## Drop names by wrapping around as.vector()
startval.l <- list(a1=as.vector(startval[[1]]["a"]),
                 lambda1=as.vector(startval[[1]]["lambda"]),
                 a2=as.vector(startval[[2]]["a"]),
```

```

lambda2=as.vector(startval[[2]]["lambda"]))

## Fit the 2 process model
bout.fit <- bouts2.nls(lnfreq, start=startval.1, maxiter=500)
summary(bout.fit)
plotBouts(bout.fit)

## Estimated BEC
bec2(bout.fit)

```

bouts3NLS

Fit mixture of 3 Poisson Processes to Log Frequency data

Description

Functions to model a mixture of 3 random Poisson processes to histogram-like data of log frequency vs interval mid points. This follows Sibly et al. (1990) method, adapted for a three-process model by Berdoy (1993).

Usage

```

bouts3.nlsFUN(x, a1, lambda1, a2, lambda2, a3, lambda3)
bouts3.nls(lnfreq, start, maxiter)
bouts3.nlsBEC(fit)
plotBouts3.nls(fit, lnfreq, bec.lty, ...)

```

Arguments

| | |
|--|---|
| <code>x</code> | numeric vector with values to model. |
| <code>a1, lambda1, a2, lambda2, a3, lambda3</code> | numeric: parameters from the mixture of Poisson processes. |
| <code>lnfreq</code> | data.frame with named components <i>lnfreq</i> (log frequencies) and corresponding <i>x</i> (mid points of histogram bins). |
| <code>start, maxiter</code> | Arguments passed to nls . |
| <code>fit</code> | nls object. |
| <code>bec.lty</code> | Line type specification for drawing the BEC reference line. |
| <code>...</code> | Arguments passed to plot.default . |

Details

`bouts3.nlsFUN` is the function object defining the nonlinear least-squares relationship in the model. It is not meant to be used directly, but is used internally by `bouts3.nls`.

`bouts3.nls` fits the nonlinear least-squares model itself.

`bouts3.nlsBEC` calculates the BEC from a list object, as the one that is returned by [nls](#), representing a fit of the model. `plotBouts3.nls` plots such an object.

Value

bouts3.nlsFUN returns a numeric vector evaluating the mixture of 3 Poisson process.

bouts3.nls returns an nls object resulting from fitting this model to data.

bouts3.nlsBEC returns a number corresponding to the bout ending criterion derived from the model.

plotBouts3.nls plots the fitted model with the corresponding data.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

References

Sibly, R.; Nott, H. and Fletcher, D. (1990) Splitting behaviour into bouts. *Animal Behaviour* **39**, 63-69.

Berdoy, M. (1993) Defining bouts of behaviour: a three-process model. *Animal Behaviour* **46**, 387-396.

See Also

[bouts.mle](#) for a better approach; [boutfreqs](#); [boutinit](#)

Examples

```
## Too long for checks
## Using the Example from '?diveStats':
utils::example("diveStats", package="diveMove",
              ask=FALSE, echo=FALSE)
## Postdive durations
postdives <- tdrX.tab$postdive.dur
postdives.diff <- abs(diff(postdives))
## Remove isolated dives
postdives.diff <- postdives.diff[postdives.diff < 4000]

## Construct histogram
lnfreq <- boutfreqs(postdives.diff, bw=0.1, plot=FALSE)

startval <- boutinit(lnfreq, c(50, 400))
## Drop names by wrapping around as.vector()
startval.l <- list(a1=as.vector(startval[[1]]["a"]),
                 lambda1=as.vector(startval[[1]]["lambda"]),
                 a2=as.vector(startval[[2]]["a"]),
                 lambda2=as.vector(startval[[2]]["lambda"]),
                 a3=as.vector(startval[[3]]["a"]),
                 lambda3=as.vector(startval[[3]]["lambda"]))

## Fit the 3 process model
bout.fit <- bouts3.nls(lnfreq, start=startval.l, maxiter=500)
summary(bout.fit)
```



```
plotBouts(bout.fit)

## Estimated BEC
bec3(bout.fit)
```

calibrateDepth

Calibrate Depth and Generate a "TDRcalibrate" object

Description

Detect periods of major activities in a TDR record, calibrate depth readings, and generate a [TDRcalibrate](#) object essential for subsequent summaries of diving behaviour.

Usage

```
calibrateDepth(x, dry.thr=70, wet.cond, wet.thr=3610, dive.thr=4,
              zoc.method=c("visual", "offset", "filter"), ...,
              interp.wet=FALSE,
              dive.model=c("unimodal", "smooth.spline"),
              smooth.par=0.1, knot.factor=3,
              descent.crit.q=0, ascent.crit.q=0)
```

Arguments

| | |
|------------|---|
| x | An object of class TDR for calibrateDepth or an object of class TDRcalibrate for calibrateSpeed . |
| dry.thr | numeric: dry error threshold in seconds. Dry phases shorter than this threshold will be considered as wet. |
| wet.cond | logical: indicates which observations should be considered wet. If it is not provided, records with non-missing depth are assumed to correspond to wet conditions (see ‘Details’ and ‘Note’ below). |
| wet.thr | numeric: wet threshold in seconds. At-sea phases shorter than this threshold will be considered as trivial wet. |
| dive.thr | numeric: threshold depth below which an underwater phase should be considered a dive. |
| zoc.method | character string to indicate the method to use for zero offset correction. One of “visual”, “offset”, or “filter” (see ‘Details’). |
| ... | Arguments required for ZOC methods filter (k, probs, depth.bounds (defaults to range), na.rm (defaults to TRUE)) and offset (offset). |
| interp.wet | logical: if TRUE (default is FALSE), then an interpolating spline function is used to impute NA depths in wet periods (<i>after ZOC</i>). <i>Use with caution</i> : it may only be useful in cases where the missing data pattern in wet periods is restricted to shallow depths near the beginning and end of dives. This pattern is common in some satellite-linked TDRs. |

| | |
|-----------------------------|--|
| <code>dive.model</code> | character string specifying what model to use for each dive for the purpose of dive phase identification. One of “smooth.spline” or “unimodal”, to choose among smoothing spline or unimodal regression (see ‘Details’). |
| <code>smooth.par</code> | numeric scalar representing amount of smoothing (argument <code>spar</code> in smooth.spline) when <code>dive.model="smooth.spline"</code> . If it is NULL, then the smoothing parameter is determined by Generalized Cross-validation (GCV). Ignored with default <code>dive.model="unimodal"</code> . |
| <code>knot.factor</code> | numeric scalar that multiplies the number of samples in the dive. This is used to construct the time predictor for the derivative. |
| <code>descent.crit.q</code> | numeric: critical quantile of rates of descent below which descent is deemed to have ended. |
| <code>ascent.crit.q</code> | numeric: critical quantile of rates of ascent above which ascent is deemed to have started. |

Details

This function is really a wrapper around `.detPhase`, `.detDive`, and `.zoc` which perform the work on simplified objects. It performs wet/dry phase detection, zero-offset correction of depth, and detection of dives, as well as proper labelling of the latter.

The procedure starts by zero-offset correcting depth (see ‘ZOC’ below), and then a factor is created with value “L” (dry) for rows with NAs for depth and value “W” (wet) otherwise. This assumes that TDRs were programmed to turn off recording of depth when instrument is dry (typically by means of a salt-water switch). If this assumption cannot be made for any reason, then a logical vector as long as the time series should be supplied as argument `wet.cond` to indicate which observations should be considered wet. This argument is directly analogous to the `subset` argument in [subset.data.frame](#), so it can refer to any variable in the TDR object (see ‘Note’ section below). The duration of each of these phases of activity is subsequently calculated. If the duration of a dry phase (“L”) is less than `dry.thr`, then the values in the factor for that phase are changed to “W” (wet). The duration of phases is then recalculated, and if the duration of a phase of wet activity is less than `wet.thr`, then the corresponding value for the factor is changed to “Z” (trivial wet). The durations of all phases are recalculated a third time to provide final phase durations.

Some instruments produce a peculiar pattern of missing data near the surface, at the beginning and/or end of dives. The argument `interp.wet` may help to rectify this problem by using an interpolating spline function to impute the missing data, constraining the result to a minimum depth of zero. Please note that this optional step is performed after ZOC and before identifying dives, so that interpolation is performed through dry phases coded as wet because their duration was briefer than `dry.thr`. Therefore, `dry.thr` must be chosen carefully to avoid interpolation through legitimate dry periods.

The next step is to detect dives whenever the zero-offset corrected depth in an underwater phase is below the specified dive threshold. A new factor with finer levels of activity is thus generated, including “U” (underwater), and “D” (diving) in addition to the ones described above.

Once dives have been detected and assigned to a period of wet activity, phases within dives are identified using the descent, ascent and wiggle criteria (see ‘Detection of dive phases’ below). This procedure generates a factor with levels “D”, “DB”, “B”, “BA”, “DA”, “A”, and “X”, breaking the input into descent, descent/bottom, bottom, bottom/ascent, ascent, descent/ascent (occurring when no bottom phase can be detected) and non-dive (surface), respectively.

Value

An object of class `TDRcalibrate`.

ZOC

This procedure is required to correct drifts in the pressure transducer of TDR records and noise in depth measurements. Three methods are available to perform this correction.

Method “visual” calls `plotTDR`, which plots depth and, optionally, speed vs. time with the ability of zooming in and out on time, changing maximum depths displayed, and panning through time. The button to zero-offset correct sections of the record allows for the collection of ‘x’ and ‘y’ coordinates for two points, obtained by clicking on the plot region. The first point clicked represents the offset and beginning time of section to correct, and the second one represents the ending time of the section to correct. Multiple sections of the record can be corrected in this manner, by panning through the time and repeating the procedure. In case there’s overlap between zero offset corrected windows, the last one prevails.

Method “offset” can be used when the offset is known in advance, and this value is used to correct the entire time series. Therefore, `offset=0` specifies no correction.

Method “filter” implements a smoothing/filtering mechanism where running quantiles can be applied to depth measurements in a recursive manner (Luque and Fried 2011), using `.depth.filter`. It relies on function `runquantile` from the `caTools` package. The method calculates the first running quantile defined by `probs[1]` on a moving window of size `k[1]`. The next running quantile, defined by `probs[2]` and `k[2]`, is applied to the smoothed/filtered depth measurements from the previous step, and so on. The corrected depth measurements (d) are calculated as:

$$d = d_0 - d_n$$

where d_0 is original depth and d_n is the last smoothed/filtered depth. This method is under development, but reasonable results can be achieved by applying two filters (see ‘Examples’). The default `na.rm=TRUE` works well when there are no level shifts between non-NA phases in the data, but `na.rm=FALSE` is better in the presence of such shifts. In other words, there is no reason to pollute the moving window with NAs when non-NA phases can be regarded as a continuum, so splicing non-NA phases makes sense. Conversely, if there are level shifts between non-NA phases, then it is better to retain NA phases to help the algorithm recognize the shifts while sliding the window(s). The search for the surface can be limited to specified bounds during smoothing/filtering, so that observations outside these bounds are interpolated using the bounded smoothed/filtered series.

Once the whole record has been zero-offset corrected, remaining depths below zero, are set to zero, as these are assumed to indicate values at the surface.

Detection of dive phases

The process for each dive begins by taking all observations below the dive detection threshold, and setting the beginning and end depths to zero, at time steps prior to the first and after the last, respectively. The latter ensures that descent and ascent derivatives are non-negative and non-positive, respectively, so that the end and beginning of these phases are not truncated. The next step is to fit a model to each dive. Two models can be chosen for this purpose: ‘unimodal’ (default) and ‘smooth.spline’.

Both models consist of a cubic spline, and its first derivative is evaluated to investigate changes in vertical rate. Therefore, at least 4 observations are required for each dive, so the time series is linearly interpolated at equally spaced time steps if this limit is not achieved in the current dive. Wiggles at the beginning and end of the dive are assumed to be zero offset correction errors, so depth observations at these extremes are interpolated between zero and the next observations when this occurs.

‘unimodal’:

In this default model, the spline is constrained to be unimodal (Koellmann et al. 2014), assuming the diver must return to the surface to breathe. The model is fitted using the uniReg package (see [uniReg](#)). This model and constraint are consistent with the definition of dives in air-breathers, so is certainly appropriate for this group of divers. A major advantage of this approach over the next one is that the degree of smoothing is determined via restricted maximum likelihood, and has no influence on identifying the transition between descent and ascent. Therefore, unimodal regression splines make the latter transition clearer compared to using smoothing splines.

‘smooth.spline’:

In this model, specified via `dive.model="smooth.spline"`, a smoothing spline is used to model each dive (see [smooth.spline](#)), using the chosen smoothing parameter.

Dive phases identified via this model, however, are highly sensitive to the degree of smoothing (`smooth.par`) used, thus making it difficult to determine what amount of smoothing is adequate.

A comparison between these methods is shown in the Examples section of [diveModel](#).

The first derivative of the spline is evaluated at a set of knots to calculate the vertical rate throughout the dive and determine the end of descent and beginning of ascent. This set of knots is established using a regular time sequence with beginning and end equal to the extremes of the input sequence, and with length equal to $N \times \text{knot.factor}$. Equivalent procedures are used for detecting descent and ascent phases.

Once one of the models above has been fitted to each dive, the quantile corresponding to `(descent.crit.q)` of all the positive derivatives (rate of descent) at the beginning of the dive is used as threshold for determining the end of descent. Descent is deemed to have ended at the *first* minimum derivative, and the nearest input time observation is considered to indicate the end of descent. The sign of the comparisons is reversed for detecting the ascent. If observed depth to the left and right of the derivative defining the ascent are the same, the right takes precedence.

The particular dive phase categories are subsequently defined using simple set operations.

Note

Note that the condition implied with argument `wet.cond` is evaluated after the ZOC procedure, so it can refer to corrected depth. In many cases, not all variables in the [TDR](#) object are sampled with the same frequency, so they may need to be interpolated before using them for this purpose. Note also that any of these variables may contain similar problems as those dealt with during ZOC, so programming instruments to record depth only when wet is likely the best way to ensure proper detection of wet/dry conditions.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

References

Koellmann, C., Ickstadt, K. and Fried, R. (2014) Beyond unimodal regression: modelling multimodality with piecewise unimodal, mixture or additive regression. Technical Report 8. <http://sfb876.tu-dortmund.de/FORSCHUNG/techreports.html>, SFB 876, TU Dortmund

Luque, S.P. and Fried, R. (2011) Recursive filtering for zero offset correction of diving depth time series. PLoS ONE 6:e15850

See Also

`TDRcalibrate`, `.zoc`, `.depthFilter`, `.detPhase`, `.detDive`, `plotTDR`, and `plotZOC` to visually assess ZOC procedure. See `diveModel`, `smooth.spline`, `unireg` for dive models.

Examples

```
data(divesTDR)
divesTDR

## Too long for checks
## Consider a 3 m offset, a dive threshold of 3 m, the 1% quantile for
## critical vertical rates, and a set of knots 20 times as long as the
## observed time steps. Default smoothing spline model for dive phase
## detection, using default smoothing parameter.
(dcalib <- calibrateDepth(divesTDR, dive.thr=3, zoc.method="offset",
                        offset=3, descent.crit.q=0.01, ascent.crit.q=0,
                        knot.factor=20))

## Or ZOC algorithmically with method="filter":
## filter in this dataset
(dcalib <- calibrateDepth(divesTDR, dive.thr=3, zoc.method="filter",
                        k=c(3, 5760), probs=c(0.5, 0.02), na.rm=TRUE,
                        descent.crit.q=0.01, ascent.crit.q=0,
                        knot.factor=20))
```

calibrateSpeed

Calibrate and build a "TDRcalibrate" object

Description

These functions create a `TDRcalibrate` object which is necessary to obtain dive summary statistics.

Usage

```
calibrateSpeed(x, tau=0.1, contour.level=0.1, z=0, bad=c(0, 0),
              main=slot(getTDR(x), "file"), coefs, plot=TRUE,
              postscript=FALSE, ...)
```

Arguments

| | |
|---------------|--|
| x | An object of class <code>TDR</code> for <code>calibrateDepth</code> or an object of class <code>TDRcalibrate</code> for <code>calibrateSpeed</code> . |
| tau | numeric scalar: quantile on which to regress speed on rate of depth change; passed to <code>rq</code> . |
| contour.level | numeric scalar: the mesh obtained from the bivariate kernel density estimation corresponding to this contour will be used for the quantile regression to define the calibration line. |
| z | numeric scalar: only changes in depth larger than this value will be used for calibration. |
| bad | numeric vector of length 2 indicating that only rates of depth change and speed greater than the given value should be used for calibration, respectively. |
| coefs | numeric: known speed calibration coefficients from quantile regression as a vector of length 2 (intercept, slope). If provided, these coefficients are used for calibrating speed, ignoring all other arguments, except x. |
| main, ... | Arguments passed to <code>rqPlot</code> . |
| plot | logical: whether to plot the results. |
| postscript | logical: whether to produce postscript file output. |

Details

This calibrates speed readings following the procedure outlined in Blackwell et al. (1999).

Value

An object of class `TDRcalibrate`.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

References

Blackwell S, Haverl C, Le Boeuf B, Costa D (1999). A method for calibrating swim-speed recorders. *Marine Mammal Science* 15(3):894-905.

See Also

[TDRcalibrate](#)

Examples

```
## Too long for checks
## Continuing the Example from '?calibrateDepth':
utils::example("calibrateDepth", package="diveMove",
              ask=FALSE, echo=FALSE)
```

```
dcalib # the 'TDRcalibrate' that was created

## Calibrate speed using only changes in depth > 2 m
vcalib <- calibrateSpeed(dcalib, z=2)
vcalib
```

distSpeed

Calculate distance and speed between locations

Description

Calculate distance, time difference, and speed between pairs of points defined by latitude and longitude, given the time at which all points were measured.

Usage

```
distSpeed(pt1, pt2, method=c("Meeus", "VincentyEllipsoid"))
```

Arguments

| | |
|--------|--|
| pt1 | A matrix or <code>data.frame</code> with three columns; the first a POSIXct object with dates and times for all points, the second and third numeric vectors of longitude and latitude for all points, respectively, in decimal degrees. |
| pt2 | A matrix with the same size and structure as pt1. |
| method | character indicating which of the distance algorithms from <code>geosphere</code> -package to use (only default parameters used). Only Meeus and VincentyEllipsoid are supported for now. |

Value

A matrix with three columns: distance (km), time difference (s), and speed (m/s).

Author(s)

Sebastian P. Luque <spluque@gmail.com>

Examples

```
## Using the Example from '?readLocs':
utils::example("readLocs", package="diveMove",
              ask=FALSE, echo=FALSE)

## Travel summary between successive standard locations
locs.std <- subset(locs, subset=class == "0" | class == "1" |
```

```

        class == "2" | class == "3" &
        !is.na(lon) & !is.na(lat))
## Default Meeus method
locs.std.tr <- by(locs.std, locs.std$id, function(x) {
  distSpeed(x[-nrow(x), 3:5], x[-1, 3:5])
})
lapply(locs.std.tr, head)

## Particular quantiles from travel summaries
lapply(locs.std.tr, function(x) {
  quantile(x[, 3], seq(0.90, 0.99, 0.01), na.rm=TRUE) # speed
})
lapply(locs.std.tr, function(x) {
  quantile(x[, 1], seq(0.90, 0.99, 0.01), na.rm=TRUE) # distance
})

## Travel summary between two arbitrary sets of points
pts <- seq(10)
(meeus <- distSpeed(locs[pts, 3:5], locs[pts + 1, 3:5]))
(vincenty <- distSpeed(locs[pts, 3:5],
  locs[pts + 1, 3:5],
  method="VincentyEllipsoid"))
meeus - vincenty

```

diveModel-class

Class "diveModel" for representing a model for identifying dive phases

Description

Details of model used to identify the different phases of a dive.

Objects from the Class

Objects can be created by calls of the form `new("diveModel", ...)`.

'diveModel' objects contain all relevant details of the process to identify phases of a dive. Objects of this class are typically generated during depth calibration, using `calibrateDepth`, more specifically `.cutDive`.

Slots

`label.matrix`: Object of class "matrix". A 2-column character matrix with row numbers matching each observation to the full `TDR` object, and a vector labelling the phases of each dive.

`model`: Object of class "character". A string identifying the specific model fit to dives for the purpose of dive phase identification. It should be one of 'smooth.spline' or 'unimodal'.

`dive.spline`: Object of class "smooth.spline". Details of cubic smoothing spline fit (see `smooth.spline`).

`spline.deriv`: Object of class "list". A list with the first derivative of the smoothing spline (see `predict.smooth.spline`).

`descent.crit`: Object of class "numeric". The index of the observation at which the descent was deemed to have ended (from initial surface observation).

`ascent.crit`: Object of class "numeric". the index of the observation at which the ascent was deemed to have ended (from initial surface observation).

`descent.crit.rate`: Object of class "numeric". The rate of descent corresponding to the critical quantile used.

`ascent.crit.rate`: Object of class "numeric". The rate of ascent corresponding to the critical quantile used.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

See Also

[getDiveDeriv](#), [plotDiveModel](#)

Examples

```
showClass("diveModel")

## Too long for checks
## Continuing the Example from '?calibrateDepth':
utils::example("calibrateDepth", package="diveMove",
              ask=FALSE, echo=FALSE)
dcalib # the 'TDRcalibrate' that was created

## Compare dive models for dive phase detection
diveNo <- 255
diveX <- as.data.frame(extractDive(dcalib, diveNo=diveNo))
diveX.m <- cbind(as.numeric(row.names(diveX[-c(1, nrow(diveX)), ])),
                diveX$depth[-c(1, nrow(diveX))],
                diveX$time[-c(1, nrow(diveX))])

## calibrateDepth() default unimodal regression. Number of inner knots is
## either 10 or the number of samples in the dive, whichever is larger.
(phases.uni <- diveMove:::cutDive(diveX.m, smooth.par=0.2, knot.factor=20,
                                dive.model="unimodal",
                                descent.crit.q=0.01, ascent.crit.q=0))

## Smoothing spline model, using default smoothing parameter.
(phases.spl <- diveMove:::cutDive(diveX.m, smooth.par=0.2, knot.factor=20,
                                dive.model="smooth.spline",
                                descent.crit.q=0.01, ascent.crit.q=0))

plotDiveModel(phases.spl,
              diveNo=paste(diveNo, ", smooth.par=", 0.2, sep=""))
plotDiveModel(phases.uni, diveNo=paste(diveNo))
```

dives

Sample of TDR data from a fur seal

Description

This data set is meant to show a typical organization of a TDR *.csv file, suitable as input for [readTDR](#), or to construct a [TDR](#) object. `divesTDR` is an example [TDR](#) object.

Format

Bzip2-compressed file. A comma separated value (csv) file with 69560 TDR readings, measured at 5 s intervals, with the following columns:

date Date

time Time

depth Depth in m

light Light level

temperature Temperature in degrees Celsius

speed Speed in m/s

The data are also provided as a [TDR](#) object (*.RData format) for convenience.

Details

The data are a subset of an entire TDR record, so they are not meant to make valid inferences from this particular individual/deployment.

`divesTDR` is a [TDR](#) object representation of the data in `dives`.

Source

Sebastian P. Luque, Christophe Guinet, John P.Y. Arnould

See Also

[readTDR](#), [diveStats](#).

Examples

```
zz <- system.file(file.path("data", "dives.csv"),
                  package="diveMove", mustWork=TRUE)
str(read.csv(zz, sep=";", na.strings=""))
```

| | |
|-----------|----------------------------|
| diveStats | <i>Per-dive statistics</i> |
|-----------|----------------------------|

Description

Calculate dive statistics in TDR records.

Usage

```
diveStats(x, depth.deriv=TRUE)
oneDiveStats(x, interval, speed=FALSE)
stampDive(x, ignoreZ=TRUE)
```

Arguments

| | |
|-------------|---|
| x | A TDRcalibrate-class object for <code>diveStats</code> and <code>stampDive</code> , and a data.frame containing a single dive's data (a factor identifying the dive phases, a <code>POSIXct</code> object with the time for each reading, a numeric depth vector, and a numeric speed vector) for <code>oneDiveStats</code> . |
| depth.deriv | logical: should depth derivative statistics be calculated? |
| interval | numeric scalar: sampling interval for interpreting x. |
| speed | logical: should speed statistics be calculated? |
| ignoreZ | logical: whether phases should be numbered considering all aquatic activities ("W" and "Z") or ignoring "Z" activities. |

Details

`diveStats` calculates various dive statistics based on time and depth for an entire TDR record. `oneDiveStats` obtains these statistics from a single dive, and `stampDive` stamps each dive with associated phase information.

Value

A [data.frame](#) with one row per dive detected (durations are in s, and linear variables in m):

| | |
|----------|--|
| begdesc | A <code>POSIXct</code> object, specifying the start time of each dive. |
| enddesc | A <code>POSIXct</code> object, as <code>begdesc</code> indicating descent's end time. |
| begasc | A <code>POSIXct</code> object, as <code>begdesc</code> indicating the time ascent began. |
| desctim | Descent duration of each dive. |
| botttim | Bottom duration of each dive. |
| asctim | Ascent duration of each dive. |
| divetim | Dive duration. |
| descdist | Numeric vector with last descent depth. |

| | |
|---------------------|--|
| bottdist | Numeric vector with the sum of absolute depth differences while at the bottom of each dive; measure of amount of “wiggling” while at bottom. |
| ascdist | Numeric vector with first ascent depth. |
| bottddep.mean | Mean bottom depth. |
| bottddep.median | Median bottom depth. |
| bottddep.sd | Standard deviation of bottom depths. |
| maxdep | Numeric vector with maximum depth. |
| desc.tdist | Numeric vector with descent total distance, estimated from speed. |
| desc.mean.speed | Numeric vector with descent mean speed. |
| desc.angle | Numeric vector with descent angle, from the surface plane. |
| bott.tdist | Numeric vector with bottom total distance, estimated from speed. |
| bott.mean.speed | Numeric vector with bottom mean speed. |
| asc.tdist | Numeric vector with ascent total distance, estimated from speed. |
| asc.mean.speed | Numeric vector with ascent mean speed. |
| asc.angle | Numeric vector with ascent angle, from the bottom plane. |
| postdive.dur | Postdive duration. |
| postdive.tdist | Numeric vector with postdive total distance, estimated from speed. |
| postdive.mean.speed | Numeric vector with postdive mean speed. |

If `depth.deriv=TRUE`, 21 additional columns with the minimum, first quartile, median, mean, third quartile, maximum, and standard deviation of the depth derivative for each phase of the dive. The number of columns also depends on argument `speed`.

`stampDive` returns a [data.frame](#) with phase number, activity, and start and end times for each dive.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

See Also

[calibrateDepth](#), [.detPhase](#), [TDRcalibrate-class](#)

Examples

```
## Too long for checks
## Continuing the Example from '?calibrateDepth':
utils::example("calibrateDepth", package="diveMove",
              ask=FALSE, echo=FALSE)
dcalib # the 'TDRcalibrate' that was created

tdrX <- diveStats(dcalib)
```

```
stamps <- stampDive(dcalib, ignoreZ=TRUE)
tdrX.tab <- data.frame(stamps, tdrX)
summary(tdrX.tab)
```

extractDive-methods *Extract Dives from "TDR" or "TDRcalibrate" Objects*

Description

Extract data corresponding to a particular dive(s), referred to by number.

Usage

```
## S4 method for signature 'TDR,numeric,numeric'
extractDive(obj, diveNo, id)
## S4 method for signature 'TDRcalibrate,numeric,missing'
extractDive(obj, diveNo)
```

Arguments

| | |
|--------|--|
| obj | TDR object. |
| diveNo | numeric vector or scalar with dive numbers to extract. Duplicates are ignored. |
| id | numeric vector or scalar of dive numbers from where diveNo should be chosen. |

Value

An object of class [TDR](#) or [TDRspeed](#).

Author(s)

Sebastian P. Luque <spluque@gmail.com>

Examples

```
## Too long for checks
## Continuing the Example from '?calibrateDepth':
utils::example("calibrateDepth", package="diveMove",
              ask=FALSE, echo=FALSE)
dcalib # the 'TDRcalibrate' that was created

diveX <- extractDive(divesTDR, 9, getDAct(dcalib, "dive.id"))
plotTDR(diveX, interact=FALSE)

diveX <- extractDive(dcalib, 5:10)
plotTDR(diveX, interact=FALSE)
```

plotDiveModel-methods *Methods for plotting models of dive phases*

Description

Methods for function plotDiveModel.

Usage

```
## S4 method for signature 'diveModel,missing'
plotDiveModel(x, diveNo)

## S4 method for signature 'numeric,numeric'
plotDiveModel(x, y, times.s, depths.s, d.crit, a.crit,
              diveNo=1, times.deriv, depths.deriv,
              d.crit.rate, a.crit.rate)

## S4 method for signature 'TDRcalibrate,missing'
plotDiveModel(x, diveNo)
```

Arguments

| | |
|--------------|---|
| x | A diveModel (diveMode,missing method), numeric vector of time step observations (numeric,numeric method), or TDRcalibrate object (TDRcalibrate,numeric method). |
| diveNo | integer representing the dive number selected for plotting. |
| y | numeric vector with depth observations at each time step. |
| times.s | numeric vector with time steps used to generate the smoothing spline (i.e. the knots, see diveModel). |
| depths.s | numeric vector with smoothed depth (see diveModel). |
| d.crit | integer denoting the index where descent ends in the observed time series (see diveModel). |
| a.crit | integer denoting the index where ascent begins in the observed time series (see diveModel). |
| times.deriv | numeric vector representing the time steps where the derivative of the smoothing spline was evaluated (see diveModel). |
| depths.deriv | numeric vector representing the derivative of the smoothing spline evaluated at times.deriv (see diveModel). |
| d.crit.rate | numeric scalar: vertical rate of descent corresponding to the quantile used (see diveModel). |
| a.crit.rate | numeric scalar: vertical rate of ascent corresponding to the quantile used (see diveModel). |

Methods

All methods produce a double panel plot. The top panel shows the depth against time, the cubic spline smoother, the identified descent and ascent phases (which form the basis for identifying the rest of the dive phases), while the bottom panel shows the first derivative of the smooth trace.

`signature(x = "diveModel", y = "missing")` Given a [diveModel](#) object and (possibly) the dive number that it corresponds to, the plot shows the model data.

`signature(x = "numeric", y = "numeric")` This is the main method, which requires all aspects of the model to be provided.

`signature(x = "TDRcalibrate", y = "missing")` Given a [TDRcalibrate](#) object and a dive number to extract from it, this method plots the observed data and the model. The intended use of this method is through [plotTDR](#) when `what="dive.model"`.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

See Also

[diveModel](#)

Examples

```
## Too long for checks
## Continuing the Example from '?calibrateDepth':
utils::example("calibrateDepth", package="diveMove",
              ask=FALSE, echo=FALSE)

## 'diveModel' method
dm <- getDiveModel(dcalib, 100)
plotDiveModel(dm, diveNo=100)

## 'TDRcalibrate' method
plotDiveModel(dcalib, diveNo=100)
```

Description

Main plotting method for objects of these classes. Plot and optionally set zero-offset correction windows in TDR records, with the aid of a graphical user interface (GUI), allowing for dynamic selection of offset and multiple time windows to perform the adjustment.

Usage

```
## S4 method for signature 'POSIXt,numeric'
plotTDR(x, y, concurVars=NULL, xlim=NULL, depth.lim=NULL,
        xlab="time (dd-mmm hh:mm)", ylab.depth="depth (m)",
        concurVarTitles=deparse(substitute(concurVars)),
        xlab.format="%d-%b %H:%M", sunrise.time="06:00:00",
        sunset.time="18:00:00", night.col="gray60",
        dry.time=NULL, phase.factor=NULL, plot.points=FALSE,
        interact=TRUE, key=TRUE, cex.pts=0.4, ...)
## S4 method for signature 'TDR,missing'
plotTDR(x, y, concurVars, concurVarTitles, ...)
## S4 method for signature 'TDRcalibrate,missing'
plotTDR(x, y, what=c("phases", "dive.model"),
        diveNo=seq(max(getDAct(x, "dive.id")), ...))
```

Arguments

| | |
|---------------------------|---|
| x | POSIXct object with date and time, TDR , or TDRcalibrate object. |
| y | numeric vector with depth in m. |
| concurVars | matrix with additional variables in each column to plot concurrently with depth. For the (TDR,missing) and (TDRcalibrate,missing) methods, a character vector naming additional variables from the concurrentData slot to plot, if any. |
| xlim | POSIXct or numeric vector of length 2, with lower and upper limits of time to be plotted. |
| depth.lim | numeric vector of length 2, with the lower and upper limits of depth to be plotted. |
| xlab, ylab.depth | character strings to label the corresponding y-axes. |
| concurVarTitles | character vector of titles to label each new variable given in <i>concurVars</i> . |
| xlab.format | character: format string for formatting the x axis; see strptime . |
| sunrise.time, sunset.time | character string with time of sunrise and sunset, respectively, in 24 hr format. This is used for shading night time. |
| night.col | color for shading night time. |
| dry.time | subset of time corresponding to observations considered to be dry. |
| phase.factor | factor dividing rows into sections. |
| plot.points | logical: whether to plot points. |
| interact | logical: whether to provide interactive tcltk controls and access to the associated ZOC functionality. |
| key | logical: whether to draw a key. |
| cex.pts | Passed to points to set the relative size of points to plot (if any). |

| | |
|--------|--|
| ... | For the (POSIXt,numeric) method, arguments passed to <code>par</code> for all methods; useful defaults <code>las=1</code> , <code>bty="n"</code> , and <code>mar</code> (the latter depending on whether additional concurrent data will be plotted) are provided, but they can be overridden. For other methods, except (TDRcalibrate,missing), these can be any of the arguments for the (POSIXt,numeric) method. For (TDRcalibrate,missing), these are arguments for the appropriate methods. |
| diveNo | numeric vector or scalar with dive numbers to plot. |
| what | character: what aspect of the <code>TDRcalibrate</code> to plot, which selects the method to use for plotting. |

Details

This function is used primarily to correct drifts in the pressure transducer of TDR records and noise in depth measurements via `method="visual"` in `calibrateDepth`.

Value

If called with the `interact` argument set to `TRUE`, returns a list (invisibly) with as many components as sections of the record that were zero-offset corrected, each consisting of two further lists with the same components as those returned by `locator`.

Methods

plotTDR signature(`x="TDR"`, `y="numeric"`): interactive graphical display of time-depth data, with zooming and panning capabilities.

plotTDR signature(`x="TDR"`, `y="missing"`): As method above.

plotTDR signature(`x="TDRcalibrate"`, `y="missing"`): plot selected aspects of `TDRcalibrate` object. Currently, two aspects have plotting methods:

- `phases` (Optional arguments: `concurVars`, `surface`) Plots all dives, labelled by the activity phase they belong to. It produces a plot consisting of one or more panels; the first panel shows depth against time, and additional panels show other concurrent data in the object. Optional argument `concurVars` is a character vector indicating which additional components from the `concurrentData` slot to plot, if any. Optional argument `surface` is a logical: whether to plot surface readings.
- `dive.model` Plots the dive model for the selected dive number (`diveNo` argument).

Author(s)

Sebastian P. Luque <spluque@gmail.com>, with many ideas from CRAN package `sfsmisc`.

See Also

[calibrateDepth](#), [.zoc](#)

Examples

```
## Too long for checks
## Continuing the Example from '?calibrateDepth':
utils::example("calibrateDepth", package="diveMove",
              ask=FALSE, echo=FALSE)
## Use interact=TRUE (default) to set an offset interactively
## Plot the 'TDR' object
plotTDR(getTime(divesTDR), getDepth(divesTDR), interact=FALSE)
plotTDR(divesTDR, interact=FALSE)

## Plot different aspects of the 'TDRcalibrate' object
plotTDR(dcalib, interact=FALSE)
plotTDR(dcalib, diveNo=19:25, interact=FALSE)
plotTDR(dcalib, what="dive.model", diveNo=25)
if (dev.interactive(orNone=TRUE)) {
  ## Add surface observations and interact
  plotTDR(dcalib, surface=TRUE)
  ## Plot one dive
  plotTDR(dcalib, diveNo=200)
}
```

plotZOC-methods

Methods for visually assessing results of ZOC procedure

Description

Plots for comparing the zero-offset corrected depth from a [TDRcalibrate](#) object with the uncorrected data in a [TDR](#) object, or the progress in each of the filters during recursive filtering for ZOC ([calibrateDepth](#)).

Usage

```
## S4 method for signature 'TDR,matrix'
plotZOC(x, y, xlim, ylim, ylab="Depth (m)", ...)
## S4 method for signature 'TDR,TDRcalibrate'
plotZOC(x, y, xlim, ylim, ylab="Depth (m)", ...)
```

Arguments

x TDR object.

y matrix with the same number of rows as there are observations in x, or a [TDRcalibrate](#) object.

| | |
|------|--|
| xlim | POSIXct or numeric vector of length 2, with lower and upper limits of time to be plotted. Defaults to time range of input. |
| ylim | numeric vector of length 2 (upper, lower) with axis limits. Defaults to range of input. |
| ylab | character strings to label the corresponding y-axis. |
| ... | Arguments passed to legend . |

Details

The `TDR,matrix` method produces a plot like those shown in Luque and Fried (2011).

The `TDR,TDRcalibrate` method overlays the corrected depth from the second argument over that from the first.

Value

Nothing; a plot as side effect.

Methods

plotTDR signature(`x="TDR"`, `y="matrix"`): This plot helps in finding appropriate parameters for `diveMove:::depthFilter`, and consists of three panels. The upper panel shows the original data, the middle panel shows the filters, and the last panel shows the corrected data. `method="visual"` in [calibrateDepth](#).

plotTDR signature(`x="TDR"`, `y="TDRcalibrate"`): This plots depth from the `TDRcalibrate` object over the one from the `TDR` object.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

References

Luque, S.P. and Fried, R. (2011) Recursive filtering for zero offset correction of diving depth time series. PLoS ONE 6:e15850

See Also

[calibrateDepth](#), [.zoc](#)

Examples

```
## Using the Example from '?diveStats':

## Too long for checks
utils::example("diveStats", package="diveMove",
               ask=FALSE, echo=FALSE)

## Plot filters for ZOC
```

```

## Work on first phase (trip) subset, to save processing time, since
## there's no drift nor shifts between trips
tdr <- divesTDR[1:15000]
## Try window widths (K), quantiles (P) and bound the search (db)
K <- c(3, 360); P <- c(0.5, 0.02); db <- c(0, 5)
d.filter <- diveMove:::depthFilter(depth=getDepth(tdr),
                                   k=K, probs=P, depth.bounds=db,
                                   na.rm=TRUE)

old.par <- par(no.readonly=TRUE)
plotZOC(tdr, d.filter, ylim=c(0, 6))
par(old.par)

## Plot corrected and uncorrected depth, regardless of method
## Look at three different scales
xlim1 <- c(getTime(divesTDR)[7100], getTime(divesTDR)[11700])
xlim2 <- c(getTime(divesTDR)[7100], getTime(divesTDR)[7400])
xlim3 <- c(getTime(divesTDR)[7100], getTime(divesTDR)[7200])
par(mar=c(3, 4, 0, 1) + 0.1, cex=1.1, las=1)
layout(seq(3))
plotZOC(divesTDR, dcalib, xlim=xlim1, ylim=c(0, 6))
plotZOC(divesTDR, dcalib, xlim=xlim2, ylim=c(0, 70))
plotZOC(divesTDR, dcalib, xlim=xlim3, ylim=c(0, 70))
par(old.par)

```

readLocs

Read comma-delimited file with location data

Description

Read a delimited (*.csv) file with (at least) time, latitude, longitude readings.

Usage

```

readLocs(locations, loc.idCol, idCol, dateCol, timeCol=NULL,
          dtformat="%m/%d/%Y %H:%M:%S", tz="GMT",
          classCol, lonCol, latCol, alt.lonCol=NULL, alt.latCol=NULL, ...)

```

Arguments

| | |
|-----------|---|
| locations | character: a string indicating the path to the file to read, or a data.frame available in the search list. Provide the entire path if the file is not on the current directory. This can also be a text-mode connection, as allowed in read.csv . |
| loc.idCol | integer: column number containing location ID. If missing, a loc.id column is generated with sequential integers as long as the input. |

| | |
|------------|---|
| idCol | integer: column number containing an identifier for locations belonging to different groups. If missing, an id column is generated with number one repeated as many times as the input. |
| dateCol | integer: column number containing dates, and, optionally, times. |
| timeCol | integer: column number containing times. |
| dtformat | character: a string specifying the format in which the date and time columns, when pasted together, should be interpreted (see strptime) in file. |
| tz | character: a string indicating the time zone for the date and time readings. |
| lonCol | integer: column number containing longitude readings. |
| latCol | integer: column number containing latitude readings. |
| classCol | integer: column number containing the ARGOS rating for each location. |
| alt.lonCol | integer: column number containing alternative longitude readings. |
| alt.latCol | integer: Column number containing alternative latitude readings. |
| ... | Passed to read.csv |

Details

The file must have a header row identifying each field, and all rows must be complete (i.e. have the same number of fields). Field names need not follow any convention.

Value

A data frame.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

Examples

```
## Do example to define object zz with location of dataset
utils::example("sealLocs", package="diveMove",
              ask=FALSE, echo=FALSE)
locs <- readLocs(zz, idCol=1, dateCol=2,
               dtformat="%Y-%m-%d %H:%M:%S", classCol=3,
               lonCol=4, latCol=5, sep=";")

summary(locs)
```

readTDR

Read comma-delimited file with "TDR" data

Description

Read a delimited (*.csv) file containing time-depth recorder (*TDR*) data from various TDR models. Return a TDR or TDRspeed object. `createTDR` creates an object of one of these classes from other objects.

Usage

```
readTDR(file, dateCol=1, timeCol=2, depthCol=3, speed=FALSE,
        subsamp=5, concurrentCols=4:6,
        dtformat="%d/%m/%Y %H:%M:%S", tz="GMT", ...)
createTDR(time, depth,
          concurrentData=data.frame(matrix(ncol=0, nrow=length(time))),
          speed=FALSE, dtime, file)
```

Arguments

| | |
|-----------------------------|--|
| <code>file</code> | character: a string indicating the path to the file to read. This can also be a text-mode connection, as allowed in read.csv . |
| <code>dateCol</code> | integer: column number containing dates, and optionally, times. |
| <code>timeCol</code> | integer: column number with times. |
| <code>depthCol</code> | integer: column number containing depth readings. |
| <code>speed</code> | logical: whether speed is included in one of the columns of <code>concurrentCols</code> . |
| <code>subsamp</code> | numeric scalar: subsample rows in <code>file</code> with <code>subsamp</code> interval, in s. |
| <code>concurrentCols</code> | integer vector of column numbers to include as concurrent data collected. |
| <code>dtformat</code> | character: a string specifying the format in which the date and time columns, when pasted together, should be interpreted (see strptime). |
| <code>tz</code> | character: a string indicating the time zone assumed for the date and time readings. |
| <code>...</code> | Passed to read.csv |
| <code>time</code> | A POSIXct object with date and time readings for each reading. |
| <code>depth</code> | numeric vector with depth readings. |
| <code>concurrentData</code> | data.frame with additional, concurrent data collected. |
| <code>dtime</code> | numeric scalar: sampling interval used in seconds. If missing, it is calculated from the <code>time</code> argument. |

Details

The input file is assumed to have a header row identifying each field, and all rows must be complete (i.e. have the same number of fields). Field names need not follow any convention. However, depth and speed are assumed to be in m, and $m \cdot s^{-1}$, respectively, for further analyses.

If `speed` is TRUE and `concurrentCols` contains a column named `speed` or `velocity`, then an object of class `TDRspeed` is created, where `speed` is considered to be the column matching this name.

Value

An object of class `TDR` or `TDRspeed`.

Note

Although `TDR` and `TDRspeed` classes check that time stamps are in increasing order, the integrity of the input must be thoroughly verified for common errors present in text output from TDR devices such as duplicate records, missing time stamps and non-numeric characters in numeric fields. These errors are much more efficiently dealt with outside of GNU R using tools like GNU `awk` or GNU `sed`, so `diveMove` does not currently attempt to fix these errors.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

Examples

```
## Do example to define object zz with location of dataset
utils::example("dives", package="diveMove",
              ask=FALSE, echo=FALSE)
srcfn <- basename(zz)
readTDR(zz, speed=TRUE, sep=";", na.strings="", as.is=TRUE)

## Or more pedestrian
tdrX <- read.csv(zz, sep=";", na.strings="", as.is=TRUE)
date.time <- paste(tdrX$date, tdrX$time)
tdr.time <- as.POSIXct(strptime(date.time, format="%d/%m/%Y %H:%M:%S"),
                      tz="GMT")
createTDR(tdr.time, tdrX$depth, concurrentData=data.frame(speed=tdrX$speed),
          file=srcfn, speed=TRUE)
```

 rqPlot

Plot of quantile regression for speed calibrations

Description

Plot of quantile regression for assessing quality of speed calibrations

Usage

```
rqPlot(rddepth, speed, z, contours, rqFit, main="qtRegression",
       xlab="rate of depth change (m/s)", ylab="speed (m/s)",
       colramp=colorRampPalette(c("white", "darkblue")),
       col.line="red", cex.pts=1)
```

Arguments

| | |
|------------|---|
| speed | numeric vector with speed in m/s. |
| rddepth | numeric vector with rate of depth change. |
| z | list with the bivariate kernel density estimates (1st component the x points of the mesh, 2nd the y points, and 3rd the matrix of densities). |
| contours | list with components: pts which should be a matrix with columns named x and y, level a number indicating the contour level the points in pts correspond to. |
| rqFit | object of class "rq" representing a quantile regression fit of rate of depth change on mean speed. |
| main | character: string with title prefix to include in output plot. |
| xlab, ylab | character vectors with axis labels. |
| colramp | function taking an integer n as an argument and returning n colors. |
| col.line | color to use for the regression line. |
| cex.pts | numeric: value specifying the amount by which to enlarge the size of points. |

Details

The dashed line in the plot represents a reference indicating a one to one relationship between speed and rate of depth change. The other line represent the quantile regression fit.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

See Also

[diveStats](#)

sealLocs

Ringed and Gray Seal ARGOS Satellite Location Data

Description

Satellite locations of a gray (Stephanie) and a ringed (Ringy) seal caught and released in New York.

Format

Bzip2-compressed file. A `data.frame` with the following information:

- id** String naming the seal the data come from.
- time** The date and time of the location.
- class** The ARGOS location quality classification.
- lon, lat** x and y geographic coordinates of each location.

Source

WhaleNet Satellite Tracking Program <http://whale.wheelock.edu/Welcome.html>.

See Also

[readLocs](#), [distSpeed](#).

Examples

```
zz <- system.file(file.path("data", "sealLocs.csv"),
                  package="diveMove", mustWork=TRUE)
str(read.csv(zz, sep=";"))
```

TDR-accessors

Coerce, Extractor, and Replacement methods for class "TDR" objects

Description

Basic methods for manipulating objects of class `TDR`.

Show Method

show `signature(object="TDR")`: print an informative summary of the data.

Coerce Methods

as.data.frame `signature(x="TDR")`: Coerce object to `data.frame`. This method returns a data frame, with attributes "file" and "dtime" indicating the source file and the interval between samples.

as.data.frame `signature(x="TDRspeed")`: Coerce object to `data.frame`. Returns an object as for `TDR` objects.

as.TDRspeed `signature(x="TDR")`: Coerce object to `TDRspeed` class.

Extractor Methods

`[signature(x="TDR", i="numeric", j="missing", drop="missing")`: Subset a TDR object; these objects can be subsetted on a single index *i*. Selects given rows from object.

getDepth `signature(x = "TDR")`: depth slot accessor.

getCCData `signature(x="TDR", y="missing")`: concurrentData slot accessor.

getCCData `signature(x="TDR", y="character")`: access component named *y* in *x*.

getDtime `signature(x = "TDR")`: sampling interval accessor.

getFileName `signature(x="TDR")`: source file name accessor.

getTime `signature(x = "TDR")`: time slot accessor.

getSpeed `signature(x = "TDRspeed")`: speed accessor for TDRspeed objects.

Replacement Methods

depth<- `signature(x="TDR")`: depth replacement.

speed<- `signature(x="TDR")`: speed replacement.

ccData<- `signature(x="TDR")`: concurrent data frame replacement.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

See Also

[extractDive](#), [plotTDR](#).

Examples

```
data(divesTDR)

## Retrieve the name of the source file
getFileName(divesTDR)
## Retrieve concurrent temperature measurements
temp <- getCCData(divesTDR, "temperature"); head(temp)
temp <- getCCData(divesTDR); head(temp)

## Coerce to a data frame
dives.df <- as.data.frame(divesTDR)
head(dives.df)

## Replace speed measurements
newspeed <- getSpeed(divesTDR) + 2
speed(divesTDR) <- newspeed
```

TDR-class

Classes "TDR" and "TDRspeed" for representing TDR information

Description

These classes store information gathered by time-depth recorders.

Details

Since the data to store in objects of these classes usually come from a file, the easiest way to construct such objects is with the function [readTDR](#) to retrieve all the necessary information. The methods listed above can thus be used to access all slots.

Objects from the Class

Objects can be created by calls of the form `new("TDR", ...)` and `new("TDRspeed", ...)`.

'TDR' objects contain concurrent time and depth readings, as well as a string indicating the file the data originates from, and a number indicating the sampling interval for these data. 'TDRspeed' extends 'TDR' objects containing additional concurrent speed readings.

Slots

In class *TDR*:

file: Object of class 'character', string indicating the file where the data comes from.

dtime: Object of class 'numeric', sampling interval in seconds.

ttime: Object of class [POSIXct](#), time stamp for every reading.

depth: Object of class 'numeric', depth (m) readings.

concurrentData: Object of class [data.frame](#), optional data collected concurrently.

Class 'TDRspeed' must also satisfy the condition that a component of the `concurrentData` slot is named `speed` or `velocity`, containing the measured speed, a vector of class 'numeric' containing speed measurements in (m/s) readings.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

See Also

[readTDR](#), [TDRcalibrate](#).

TDRcalibrate-accessors

Methods to Show and Extract Basic Information from "TDRcalibrate" Objects

Description

Show and extract information from [TDRcalibrate](#) objects.

Usage

```
## S4 method for signature 'TDRcalibrate,missing'
getDAct(x)
## S4 method for signature 'TDRcalibrate,character'
getDAct(x, y)
## S4 method for signature 'TDRcalibrate,missing'
getDPhaseLab(x)
## S4 method for signature 'TDRcalibrate,numeric'
getDPhaseLab(x, diveNo)
## S4 method for signature 'TDRcalibrate,missing'
getDiveModel(x)
## S4 method for signature 'TDRcalibrate,numeric'
getDiveModel(x, diveNo)
## S4 method for signature 'diveModel'
getDiveDeriv(x, phase=c("all", "descent", "bottom", "ascent"))
## S4 method for signature 'TDRcalibrate'
getDiveDeriv(x, diveNo, phase=c("all", "descent", "bottom", "ascent"))
## S4 method for signature 'TDRcalibrate,missing'
getGAct(x)
## S4 method for signature 'TDRcalibrate,character'
getGAct(x, y)
## S4 method for signature 'TDRcalibrate'
getSpeedCoef(x)
## S4 method for signature 'TDRcalibrate'
getTDR(x)
```

Arguments

| | |
|--------|--|
| x | TDRcalibrate object. |
| diveNo | numeric vector with dive numbers to extract information from. |
| y | string; “dive.id”, “dive.activity”, or “postdive.id” in the case of <code>getDAct</code> , to extract the numeric dive ID, the factor identifying activity phases (with underwater and diving levels possibly represented), or the numeric postdive ID, respectively. In the case of <code>getGAct</code> it should be one of “phase.id”, “activity”, “begin”, or “end”, to extract the numeric phase ID for each observation, a factor indicating |

what major activity the observation corresponds to (where diving and underwater levels are not represented), or the beginning and end times of each phase in the record, respectively.

`phase` character vector indicating phase of the dive for which to extract the derivative.

Value

The extractor methods return an object of the same class as elements of the slot they extracted.

Show Methods

show signature(object="TDRcalibrate"): prints an informative summary of the data.

show signature(object="diveModel"): prints an informative summary of a dive model.

Extractor Methods

getDAct signature(x="TDRcalibrate", y="missing"): this accesses the `dive.activity` slot of [TDRcalibrate](#) objects. Thus, it extracts a data frame with vectors identifying all readings to a particular dive and postdive number, and a factor identifying all readings to a particular activity.

getDAct signature(x="TDRcalibrate", y="character"): as the method for missing y, but selects a particular vector to extract. See [TDRcalibrate](#) for possible strings.

getDPhaseLab signature(x="TDRcalibrate", diveNo="missing"): extracts a factor identifying all readings to a particular dive phase. This accesses the `dive.phases` slot of [TDRcalibrate](#) objects, which is a factor.

getDPhaseLab signature(x="TDRcalibrate", diveNo="numeric"): as the method for missing y, but selects data from a particular dive number to extract.

getDiveModel signature(x="TDRcalibrate", diveNo="missing"): extracts a list with all dive phase models. This accesses the `dive.models` slot of [TDRcalibrate](#) objects.

getDiveModel signature(x="TDRcalibrate", diveNo="numeric"): as the method for missing `diveNo`, but selects data from a particular dive number to extract.

getDiveDeriv signature(x="TDRcalibrate"): extracts the derivative (list) of the dive model (smoothing spline) from the `dive.models` slot of [TDRcalibrate](#) objects for one or all phases of a dive.

getDiveDeriv signature(x="diveModel"): as the method for [TDRcalibrate](#), but selects data from one or all phases of a dive.

getGAct signature(x="TDRcalibrate", y="missing"): this accesses the `gross.activity` slot of [TDRcalibrate](#) objects, which is a named list. It extracts elements that divide the data into major wet and dry activities.

getGAct signature(x="TDRcalibrate", y="character"): as the method for missing y, but extracts particular elements.

getTDR signature(x="TDRcalibrate"): this accesses the `tdr` slot of [TDRcalibrate](#) objects, which is a [TDR](#) object.

getSpeedCoef signature(x="TDRcalibrate"): this accesses the `speed.calib.coefs` slot of [TDRcalibrate](#) objects; the speed calibration coefficients.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

See Also

[diveModel](#), [plotDiveModel](#), [plotTDR](#).

Examples

```
## Too long for checks
## Continuing the Example from '?calibrateDepth':
utils::example("calibrateDepth", package="diveMove",
              ask=FALSE, echo=FALSE)
dcalib # the 'TDRcalibrate' that was created

## Beginning times of each successive phase in record
getGAct(dcalib, "begin")

## Factor of dive IDs
dids <- getDAct(dcalib, "dive.id")
table(dids[dids > 0]) # samples per dive

## Factor of dive phases for given dive
getDPhaseLab(dcalib, 19)
## Full dive model
(dm <- getDiveModel(dcalib, 19))
str(dm)

## Derivatives
getDiveDeriv(dcalib, diveNo=19)
(derivs.desc <- getDiveDeriv(dcalib, diveNo=19, phase="descent"))
(derivs.bott <- getDiveDeriv(dcalib, diveNo=19, phase="bottom"))
(derivs.asc <- getDiveDeriv(dcalib, diveNo=19, phase="ascent"))
if (require(lattice)) {
  fl <- c("descent", "bottom", "ascent")
  bwplot(~ derivs.desc$y + derivs.bott$y + derivs.asc$y,
         outer=TRUE, allow.multiple=TRUE, layout=c(1, 3),
         xlab=expression(paste("Vertical rate (", m %.% s^-1, ")")),
         strip=strip.custom(factor.levels=fl))
}
```

Description

This class holds information produced at various stages of dive analysis. Methods are provided for extracting data from each slot.

Details

This is perhaps the most important class in `diveMove`, as it holds all the information necessary for calculating requested summaries for a TDR.

Objects from the Class

Objects can be created by calls of the form `new("TDRcalibrate", ...)`. The objects of this class contain information necessary to divide the record into sections (e.g. dry/water), dive/surface, and different sections within dives. They also contain the parameters used to calibrate speed and criteria to divide the record into phases.

Slots

`call`: Object of class `call`.

The matched call to the function that created the object.

`tdr`: Object of class `TDR`.

This slot contains the time, zero-offset corrected depth, and possibly a data frame. If the object is also of class "TDRspeed", then the data frame might contain calibrated or uncalibrated speed. See `readTDR` and the accessor function `getTDR` for this slot.

`gross.activity`: Object of class 'list'.

This slot holds a list of the form returned by `.detPhase`, composed of 4 elements. It contains a vector (named `phase.id`) numbering each major activity phase found in the record, a factor (named `activity`) labelling each row as being dry, wet, or trivial wet activity. These two elements are as long as there are rows in `tdr`. This list also contains two more vectors, named `begin` and `end`: one with the beginning time of each phase, and another with the ending time; both represented as `POSIXct` objects. See `.detPhase`.

`dive.activity`: Object of class `data.frame`.

This slot contains a `data.frame` of the form returned by `.detDive`, with as many rows as those in `tdr`, consisting of three vectors named: `dive.id`, which is an integer vector, sequentially numbering each dive (rows that are not part of a dive are labelled 0), `dive.activity` is a factor which completes that in `activity` above, further identifying rows in the record belonging to a dive. The third vector in `dive.activity` is an integer vector sequentially numbering each postdive interval (all rows that belong to a dive are labelled 0). See `.detDive`, and `getDACT` to access all or any one of these vectors.

`dive.phases`: Object of class 'factor'. This slot is a factor that labels each row in the record as belonging to a particular phase of a dive. It has the same form as the "phase.labels" component of the list returned by `.labDivePhase`.

`dive.models`: Object of class 'list'. This slot contains the details of the process of dive phase identification for each dive. It has the same form as the `dive.models` component of the list returned by `.labDivePhase`. It has as many components as there are dives in the `TDR` object, each of them of class `diveModel`.

`dry.thr`: Object of class 'numeric' the temporal criteria used for detecting dry periods that should be considered as wet.

`wet.thr`: Object of class 'numeric' the temporal criteria used for detecting periods wet that should not be considered as foraging time.

`dive.thr`: Object of class 'numeric' the criteria used for defining a dive.

`speed.calib.coefs`: Object of class 'numeric' the intercept and slope derived from the speed calibration procedure. Defaults to $c(0, 1)$ meaning uncalibrated speeds.

Author(s)

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See Also

[TDR](#) for links to other classes in the package. [TDRcalibrate-methods](#) for the various methods available.

timeBudget-methods *Describe the Time Budget of Major Activities from "TDRcalibrate" object.*

Description

Summarize the major activities recognized into a time budget.

Usage

```
## S4 method for signature 'TDRcalibrate,logical'
timeBudget(obj, ignoreZ)
```

Arguments

`obj` [TDRcalibrate](#) object.
`ignoreZ` logical: whether to ignore trivial aquatic periods.

Details

Ignored trivial aquatic periods are collapsed into the enclosing dry period.

Value

A [data.frame](#) with components:

`phaseno` A numeric vector numbering each period of activity.
`activity` A factor labelling the period with the corresponding activity.
`beg, end` [POSIXct](#) objects indicating the beginning and end of each period.

Author(s)

Sebastian P. Luque <spluque@gmail.com>

See Also

[calibrateDepth](#)

Examples

```
## Too long for checks
## Continuing the Example from '?calibrateDepth':
utils::example("calibrateDepth", package="diveMove",
              ask=FALSE, echo=FALSE)
dcalib # the 'TDRcalibrate' that was created

timeBudget(dcalib, TRUE)
```

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