

Package ‘trajectories’

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Title Classes and Methods for Trajectory Data

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spatstat.geom, taxidata, sf, XML, devtools, jsonlite, ks, maps

Description Classes and methods for trajectory data, with support for nesting individual Track objects in track sets (Tracks) and track sets for different entities in collections of Tracks. Methods include selection, generalization, aggregation, intersection, simulation, and plotting.

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URL <https://github.com/edzer/trajectories>

Additional_repositories <https://cran.uni-muenster.de/pebesma/>

BugReports <https://github.com/edzer/trajectories/issues>

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difftrack.R compare-methods.R rtracks.R Trackstat.R

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```
as.list.TracksCollection
      as.list.TracksCollection
```

Description

Convert a "TracksCollection" object to a list of tracks

Usage

```
## S3 method for class 'TracksCollection'
as.list(x,...)
```

Arguments

```
x          an object of class "TracksCollection"
...        passed to arguments of as.list
```

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[rTrack](#), [rTracks](#), [rTracksCollection](#), [as.list](#)

Examples

```
x <- rTracksCollection()
as.list(x)
```

```
as.Track          Converts data to an object of class "Track"
```

Description

Function as.Track accepts converts x,y coordinates and thier corresponding time/date to an object of class Track. It can also accepts covariates for the corresponding locations, covariates must be a dataframe with some columns and length of each column is equal to length of x,y,t.

Usage

```
as.Track(x,y,t,covariate)
```

Arguments

x	x coordinate.
y	y coordinate.
t	corresponding time and date of x,y.
covariate	additional information.

Details

An object of class "Track" can be created by some geographical locations and corresponding time/dates. Function as.Track converts locations and dates/times to an object of class "Track". time/date should be from class "POSIXct" "POSIXt". See example below.

Value

An object of class "Track".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[Track](#), [as.POSIXct](#)

Examples

```
x <- runif(10,0,1)
y <- runif(10,0,1)
date <- seq(as.POSIXct("2015-1-1 0:00"), as.POSIXct("2015-1-1 9:00"), by = "hour")
Z <- as.Track(x,y,date)
plot(Z)
```

as.Track.arrow

Convert trajectory pattern to a list of marked point patterns

Description

Converting a list of Track objects to a list of marked point patterns. Each mark shows the length of movement.

Usage

```
as.Track.arrow(X,timestamp,epsilon=epsilon)
```

Arguments

X	A list of Track objects
timestamp	based on secs, mins,...
epsilon	(optional) movements with length less than epsilon are not considered in the calculation

Details

Converting a list of Track objects to a list of marked point patterns. Marks show the length of movement with respect to the previous location.

Value

a list of marked point patterns.

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[rTrack](#), [as.Track.ppp](#)

Examples

```
if (require(spatstat.geom)) {
  X <- list()
  for(i in 1:10){
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)
    X[[i]] <- rTrack(bbox = m,transform = TRUE)
  }
  Y <- as.Track.arrow(X,timestamp="120 secs")
}
```

as.Track.ppp

Conver trajectory pattern to a list of objects of class ppp

Description

This function converts a list of Tracks to a list of point patterns (class "ppp")

Usage

```
as.Track.ppp(X,timestamp)
```

Arguments

X a list of Track objects
timestamp based on secs, mins,...

Details

as.Track.ppp converts a list of Track objects to a list of ppp objects.

Value

A list of point patterns, objects of class "ppp".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[avedistTrack](#), [as.ppp](#)

Examples

```
if (require(spatstat.geom)) {  
  X <- list()  
  for(i in 1:10){  
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)  
    X[[i]] <- rTrack(bbox = m,transform = TRUE)  
  }  
  Y <- as.Track.ppp(X,timestamp="120 secs")  
}
```

auto.arima.Track *Fitting arima model to a track*

Description

Fit arima models to objects of class "Track".

Usage

```
auto.arima.Track(X, ...)
```

Arguments

X an object of class "Track"
... passed to arguments of [auto.arima](#)

Details

This fits arima models to the x,y locations of objects of class "Track".

Value

an object of class "ArimaTrack"

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[rTrack](#), [auto.arima](#)

Examples

```
if (require(forecast)) {  
  X <- rTrack()  
  auto.arima.Track(X)  
}
```

avedistTrack

Average pairwise distance of trajectory pattern over time

Description

This measures the average of pairwise distances between tracks over time.

Usage

```
avedistTrack(X,timestamp)
```

Arguments

X	a list of some objects of class "Track"
timestamp	timestamp to calculate the pairwise distances between tracks

Details

This function calculates the average pairwise distance between a list of tracks according to a given timestamp.

Value

An object of class "distrack". It can be plotted over time.

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[as.Track.ppp](#)

Examples

```
if (require(spatstat.geom)) {  
  X <- list()  
  for(i in 1:10){  
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)  
    X[[i]] <- rTrack(bbox = m,transform = TRUE)  
  }  
  
  ave <- avedistTrack(X,timestamp = "120 secs")  
  plot(ave,type="l")  
}
```

avemove

Average movement of trajectory pattern

Description

This returns the average movements of a lits of objects of class "Track" over time.

Usage

```
avemove(X,timestamp,epsilon=epsilon)
```

Arguments

X	a list of some objects of class Track
timestamp	timestamp to calculate the pairwise distances between tarcks
epsilon	(optional) movements with length less than epsilon are not considered in the calculation

Details

when analysying a list of tracks, avemove calculate the average of movements based on given timestamp.

Value

an object of class "numeric" or "arwlen".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[as.Track.arrow](#)

Examples

```
if (require(spatstat.geom)) {
  X <- list()
  for(i in 1:10){
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)
    X[[i]] <- rTrack(bbox = m,transform = TRUE)
  }
  avemove(X,timestamp = "30 secs")
}
```

chimaps

Chimaps of tarjectory pattern.

Description

Computes the chimaps, corresponding to a list of objects of class "Track". chimaps are based on the discrepancy between computed and expected intensity in a given location.

Usage

```
chimaps(X,timestamp,rank,...)
```

Arguments

X	A list of Track objects
timestamp	based on secs,mins,...
rank	a number between one and the length of corresponding time sequence which is created based on given timestamp.
...	passed to arguments of density.Track

Details

$[\text{estimated intensity} - \text{expected intensity}] / \sqrt{\text{expected intensity}}$.

Value

an image of class "im".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[density.list](#), [density.ppp](#)

Examples

```
if (require(spatstat.geom)) {  
  X <- list()  
  for(i in 1:10){  
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)  
    X[[i]] <- rTrack(bbox = m,transform = TRUE)  
  }  
  chimaps(X, timestamp = "180 secs",rank = 2)  
}
```

compare

Compares objects of class Track

Description

Calculates distances between two tracks for the overlapping time interval.

Usage

```
## S4 method for signature 'Track'  
compare(tr1, tr2)
```

Arguments

tr1 An object of class Track.
tr2 An object of class Track.

Value

A difftrack object. Includes both tracks extended with additional points for the timestamps of the other track. Also includes SpatialLines representing the distances between the tracks.

Author(s)

Nikolai Gorte <n.gorte@gmail.com>

Examples

```
## example tracks
library(sp)
library(xts)
data(A3)
track2 <- A3
index(track2@time) <- index(track2@time) + 32
track2@sp@coords <- track2@sp@coords + 0.003

## compare and plot
difftrack <- compare(A3, track2)
plot(difftrack)
```

cut

obtain ranges of space and time coordinates

Description

obtain ranges of space and time coordinates

Usage

```
## S3 method for class 'Track'
cut(x, breaks, ..., include.lowest = TRUE, touch = TRUE)
## S3 method for class 'Tracks'
cut(x, breaks, ...)
## S3 method for class 'TracksCollection'
cut(x, breaks, ...)
```

Arguments

x	object of class Track, Tracks or TracksCollection
breaks	define the breaks; see cut
...	passed down to Tracks and Track methods, then to cut
include.lowest	see cut
touch	logical; if FALSE, Track objects will be formed from unique sets of points, meaning that gaps between two consecutive Track objects will arise; if TRUE, the first point from each next track is copied, meaning that sets of Track are seamless.

Details

sub-trajectories can be invalid, if they have only one point, and are ignored. This can happen at the start only if touch=FALSE, and at the end in any case.

Value

The cut method applied to a Track object cuts the track in pieces, and hence returns a Tracks object. cut.Tracks returns a Tracks object, cut.TracksCollection returns a TracksCollection.

Examples

```
# example might take too long for CRAN checks
data(storms)
dim(storms)
dim(cut(storms, "week", touches = FALSE)) # same number of geometries
dim(cut(storms, "week")) # increase of geometries = increase of tracks
```

 density.list

Kernel estimate of intensity of trajectory pattern

Description

Estimating the intensity of a list of tracks.

Usage

```
## S3 method for class 'list'
density(x, timestamp,...)
```

Arguments

x	a list of "Track" objects, an object of class "Tracks" or "TracksCollection"
timestamp	based on secs, mins, ...
...	passed to arguments of density.ppp

Details

This estimate the average intensity function of moving objects over time. Bandwidth selection methods such as bw.diggle, bw.scott and bw.ppl can be passed to this density.list.

Value

an image of class "im".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[rTrack](#), [density.ppp](#)

Examples

```

if (require(spatstat.explore)) {
  X <- list()
  for(i in 1:10){
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)
    X[[i]] <- rTrack(bbox = m,transform = TRUE)
  }
  density(X, timestamp = "180 secs")
}

```

difftrack-class *Class "difftrack"*

Description

Class that represents differences between two [Track](#) objects.

Objects from the Class

Objects can be created by calls of the form `new("difftrack", ...)`. Objects of class `difftrack` contain 2 objects of class [Track](#) extended with points for timestamps of the other track and 2 [SpatialLinesDataFrame](#) containing the the lines and distances between tracks.

Slots

track1: Extended track1
 track2: Extended track2
 conns1: Lines between the original track1 and the new points on track2
 conns2: Lines between the original track2 and the new points on track1

Methods

plot signature(x = "difftrack", y = "missing"): plot a difftrack

Author(s)

Nikolai Gorte <n.gorte@gmail.com>

Examples

```

showClass("difftrack")
## example tracks
library(sp)
library(xts)
data(A3)
track2 <- A3
index(track2@time) <- index(track2@time) + 32
track2@sp@coords <- track2@sp@coords + 0.003

```



```
## create Tracks objects
tracks1 <- Tracks(list(A3, track2))
tracks2 <- Tracks(list(track2, A3))

## calculate distances
## Not run:
dists(tracks1, tracks2)
dists(tracks1, tracks2, sum)
dists(tracks1, tracks2, frechetDist)

## End(Not run)
```

downsample

Downsample a Track

Description

Downsamples a Track to the size (amount of points) of another Track.

Usage

```
## S4 method for signature 'Track'
downsample(track1, track2)
```

Arguments

track1 Track that will be downsampled.
track2 Reference Track.

Value

A Track object. The downsampled track1.

Author(s)

Nikolai Gorte <n.gorte@gmail.com>

frechetDist	<i>Frechet distance</i>
-------------	-------------------------

Description

Compute the discrete Frechet distance between two Track objects.

Usage

```
## S4 method for signature 'Track'  
frechetDist(track1, track2)
```

Arguments

track1	An object of class Track.
track2	An object of class Track.

Value

Discrete Frechet distance.

Author(s)

Nikolai Gorte <n.gorte@gmail.com>

References

http://en.wikipedia.org/wiki/Frechet_distance

generalize	<i>Generalize objects of class Track, Tracks and TracksCollection</i>
------------	---

Description

Generalize objects of class Track, Tracks and TracksCollection.

Usage

```
## S4 method for signature 'Track'  
generalize(t, FUN = mean, ..., timeInterval, distance, n, tol, toPoints)  
## S4 method for signature 'Tracks'  
generalize(t, FUN = mean, ...)  
## S4 method for signature 'TracksCollection'  
generalize(t, FUN = mean, ...)
```

Arguments

t	An object of class Track, Tracks or TracksCollection.
FUN	The generalization method to be applied. Defaults to mean if none is passed.
timeInterval	(lower limit) time interval to split Track into segments
distance	(lower limit) distance to split Track into segments
n	number of points to form segments
tol	tolerance passed on to st_simplify , to generalize segments using the Douglas-Peucker algorithm.
toPoints	keep mid point rather than forming SpatialLines segments
...	Additional arguments passed to FUN

Value

An object of class Track, Tracks or TracksCollection.

Kinhom.Track	<i>Inhomogeneous K-function for trajectory pattern</i>
--------------	--

Description

Estimate the variability area of K-function of a list of tracks.

Usage

```
Kinhom.Track(X, timestamp,
             correction=c("border", "bord.modif", "isotropic", "translate"), q,
             sigma=c("default", "bw.diggle", "bw.ppl", "bw.scott"), ...)
```

Arguments

X	A list of Track objects
timestamp	based on secs,mins,...
correction	the type of correction to be used in computing K-function
q	(optional) a numeric value between 0 and 1. quantile to be applied to calculate the variability area
sigma	method to be used in computing intensity function
...	passed to the arguments of Kinhom

Details

This calculates the variability area of K-function over time. If sigma=default, it calculates the variability area using the defaults of Kinhom, otherwise it first estimate the intensity function using the given sigma as bandwidth selection method and then using the estimated intensity function, it estimates the variability area.

Value

an object of class "KTrack".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[rTrack](#), [as.Track.ppp](#), [Kinhom](#)

Examples

```
if (require(spatstat)) {
  X <- list()
  for(i in 1:50){
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)
    X[[i]] <- rTrack(bbox = m,transform = TRUE)
  }
  Kinhom.Track(X, timestamp = "180 secs")
}
```

pcfinhom.Track *Pair correlation function of trajectory pattern*

Description

Pair correlation function of trajectory pattern

Usage

```
pcfinhom.Track(X,timestamp,correction = c("translate", "Ripley"),q,
  sigma=c("default","bw.diggle","bw.ppl","bw.scott"),...)
```

Arguments

X	A list of Track objects
timestamp	based on secs,mins,...
correction	the type of correction to be used in computing pair correlation function
q	(optional) a numeric value between 0 and 1. quantile to be applied to calculate the variability area
sigma	method to be used in computing intensity function
...	passed to the arguments of pcfinhom

Details

This calculates the variability area of pair correlation function over time. If sigma=default, it calculates the variability area using the defaults of pcfinhom, otherwise it first estimate the intensity function using the given sigma as bandwidth selection method and then using the estimated intensity function, it estimates the variability area.

Value

an object of class "gTrack"

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[rTrack](#), [as.Track.ppp](#), [pcfinhom](#)

Examples

```
if (require(spatstat.explore)) {
  X <- list()
  for(i in 1:100){
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)
    X[[i]] <- rTrack(bbox = m,transform = TRUE)
  }
  g <- pcfinhom.Track(X,timestamp = "180 sec")
  plot(g)
}
```

plot.arwlen

Methods for class "arwlen"

Description

Methods for class "arwlen"

Usage

```
## S3 method for class 'arwlen'
plot(x, ...)
```

Arguments

x an object of class "arwlen"
... passed on to plot

Value

a plot.

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

avemove

`plot.distrack` *Methods for class "distrack"*

Description

The plot method for "distrack" objects.

Usage

```
## S3 method for class 'distrack'  
plot(x, ...)
```

Arguments

<code>x</code>	an object of class "distrack"
<code>...</code>	ignored

Details

This plots an object of class "distrack".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

plot.gTrack

Methods for class "gTrack"

Description

plot method

Usage

```
## S3 method for class 'gTrack'  
plot(x, type = "l", col = "grey70", cex=1, line=2.2, ...)
```

Arguments

x	an object of class "gTrack"
type	line type
col	line color
cex	used for size of legend
line	specifying a value for line overrides the default placement of labels, and places them this many lines outwards from the plot edge
...	passed on to plot

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

plot.KTrack*Methods for class "KTrack"*

Description

Methods for class "KTrack"

Usage

```
## S3 method for class 'KTrack'  
plot(x, type = "l", col = "grey70", cex=1, line=2.2, ...)
```

Arguments

x	an object of class KTrack
type	line type
col	color
cex	used for size of legend
line	specifying a value for line overrides the default placement of labels, and places them this many lines outwards from the plot edge
...	passed on to plot

Details

plotting the variability area of K-function of a list of tracks.

Value

a plot.

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

print.ArimaTrack *Methods for class "ArimaTrack"*

Description

print method.

Usage

```
## S3 method for class 'ArimaTrack'  
print(x, ...)
```

Arguments

x	an object of class "ArimaTrack"
...	ignored

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

print.arwlen *Methods for class "arwlen"*

Description

to print an object of class "arwlen".

Usage

```
## S3 method for class 'arwlen'  
print(x,...)
```

Arguments

x	an object of class "arqlen"
...	ignored

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

print.distrack *Methods for class "distrack"*

Description

This is a method for class "distrack".

Usage

```
## S3 method for class 'distrack'  
print(x,...)
```

Arguments

x	an object of class "distrack"
...	ignored

Details

This is a method for class "distrack".

Value

See the documentation on the corresponding generic function.

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

Examples

```
if (require(spatstat.geom)) {
  X <- list()
  for(i in 1:10){
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)
    X[[i]] <- rTrack(bbox = m,transform = TRUE)
  }

  ave <- avedistTrack(X,timestamp = "30 secs")
  plot(ave,type="l")
}
```

print.gTrack *Methods for class "gTrack"*

Description

print method.

Usage

```
## S3 method for class 'gTrack'
print(x,...)
```

Arguments

x an object of class "gTrack"
... ignored

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

print.KTrack *Methods for class "KTrack"*

Description

Methods for class "KTrack"

Usage

```
## S3 method for class 'KTrack'  
print(x,...)
```

Arguments

x	an object of class "KTrack"
...	ignored

Details

to print an object of class "KTrack".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

print.ppplist *Methods for class "Track"*

Description

method to print an object of class "ppplist"

Usage

```
## S3 method for class 'ppplist'  
print(x,...)
```

Arguments

x	an object of class "ppplist"
...	ignored

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

print.Track *Methods for class "Track"*

Description

method to print an object of class "Track"

Usage

```
## S3 method for class 'Track'  
print(x,...)
```

Arguments

x an object of class "Track"
... ignored

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

print.Tracks *Methods for class "Tracks"*

Description

method to print an object of class "Tracks"

Usage

```
## S3 method for class 'Tracks'  
print(x,...)
```

Arguments

x an object of class "Tracks"
... ignored

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

print.TracksCollection

Methods for class "TracksCollection"

Description

method to print an object of class "TracksCollection"

Usage

```
## S3 method for class 'TracksCollection'  
print(x, ...)
```

Arguments

x	an object of class "TracksCollection"
...	ignored

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

print.Trow

Methods for class "Trow"

Description

Print objets of class "Trow"

Usage

```
## S3 method for class 'Trow'  
print(x,...)
```

Arguments

x	an object of class "Trow"
...	ignored

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

as.Track.arrow

range.Track	<i>range.Track</i>
-------------	--------------------

Description

Retrieves the range of a "Track" object

Usage

```
## S3 method for class 'Track'  
range(X, ...)
```

Arguments

X	an object of class "Track"
...	passed to arguments of range

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[rTrack](#), [rTracks](#), [rTracksCollection](#), [range](#)

Examples

```
x <- rTrack()  
range(x)
```

reTrack	<i>Reconstruct objects of class "Track"</i>
---------	---

Description

Function reTrack accepts X as an object of class "Track". Output is a reconstructed Track (again an object of class Track), based on a regular "timestamp". It only returns the interpolated points.

Usage

```
reTrack(X, at=c("track", "dfrm"), timestamp=timestamp, tsq=NULL)
```

Arguments

X	an object of class Track
at	to set the type of output as either an object of class "Track" or data.frame
timestamp	timestamp which Track be reconstructed based on
tsq	a time sequence to reconstruct Track X based on it. This is optional. If this is not given, the function creates the time sequence based on timestamp.

Details

Sometimes tracks data are not collected according to a regular timestamp. In order to compare different tracks which share some time intervals, we might need to be aware of the locations in a regular timestamp. Function reTrack enables us to reconstruct an object of class "Track" based on a regular timestamp. Time sequence can be given by user, if not reTrack creates a regular time sequence based on the given timestamp.

Value

Either an object of class "Track" or a data.frame

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[rTrack](#), [as.Track](#), [as.POSIXct](#), [compare](#)

Examples

```
library(sp)
library(spacetime)
# t0 = as.POSIXct(as.Date("2013-09-30", tz="CET"))
t0 = as.POSIXct("2013-09-30 02:00:00", tz = "Europe/Berlin")

# person A, track 1:
x = c(7,6,5,5,4,3,3)
y = c(7,7,6,5,5,6,7)
n = length(x)
set.seed(131)
t = t0 + cumsum(runif(n) * 60)
crs = CRS("+proj=longlat +datum=WGS84") # longlat
stidf = STIDF(SpatialPoints(cbind(x,y),crs), t, data.frame(co2 = rnorm(n)))
A1 = Track(stidf)
reTrack(A1,timestamp = "1 sec")
```

rTrack *Generate random Track, Tracks or TracksCollection objects*

Description

Generate random Track, Tracks or TracksCollection objects

Usage

```
rTrack(n = 100, origin = c(0,0), start = as.POSIXct("1970-01-01"), ar = .8,
step = 60, sd0 = 1, bbox = bbox, transform = FALSE, nrandom = FALSE, ...)
rTracks(m = 20, start = as.POSIXct("1970-01-01"), delta = 7200, sd1 = 0,
origin = c(0,0), ...)
rTracksCollection(p = 10, sd2 = 0, ...)
```

Arguments

n	number of points per Track
origin	numeric, length two, indicating the origin of the Track
start	POSIXct, indicating the start time of the Track
ar	numeric vector, indicating the amount of correlation in the Track
step	numeric; time step(s) in seconds between Track fixes
sd0	standard deviation of the random steps in a Track
sd1	standard deviation of the consecutive Track origin values (using rnorm)
sd2	standard deviation of the consecutive Tracks origin values (using rnorm)
bbox	bbox object <code>FIXME:fill</code> in
transform	logical; <code>FIXME:fill</code> in
nrandom	logical; if TRUE, draw n from <code>rpois(n)</code>
...	rTrack: arguments passed on to <code>arima.sim</code> , rTracks: arguments passed on to rTrack; rTracksCollection: arguments passed on to rTracks
m	number of Track objects to simulate
delta	time difference between consecutive Track start times
p	number of IDs with Tracks to generate

Details

ar is passed on to `arima.sim` as ar element, and may contain multiple AR coefficients. The generated track is a `cumsum` over the simulated AR values, for each dimension. In case it has length 1 and value 0, random walk is created using `rnorm`. If `bbox` is given, the generated track will be transformed to `bbox`. If `transform` is TRUE and no `bbox` is given, it transforms the track to a unit box. If `nrandom` is TRUE, it generates a random number using `rpois` with parameter n as the number of locations per track.

Value

An object of class Track, Tracks or TracksCollection.

Author(s)

Edzer Pebesma <edzer.pebesma@uni-muenster.de>, Mohammad Mehdi Moradi <moradi@uji.es>

Examples

```
x = rTrack()
dim(x)
plot(x)
# x = rTracks(sd1 = 120)
# dim(x)
# plot(as(x, "SpatialLines"), col = 1:dim(x)[1], axes=TRUE)
# x = rTracksCollection() # star
# dim(x)
# plot(x)
x = rTracksCollection(sd2 = 200,p=4,m=10)
plot(x, col=1:dim(x)[1])
```

stbox

obtain ranges of space and time coordinates

Description

obtain ranges of space and time coordinates

Usage

```
stbox(obj)
```

Arguments

obj object of a class deriving from Tracks or TracksCollection.

Value

stbox returns a data.frame, with three columns representing x-, y- and time-coordinates, and two rows containing min and max values.

Methods

stbox signature(x = "Tracks"): obtain st range from object

stbox signature(x = "TracksCollection"): obtain st range from object

stcube *Draw a space-time cube.*

Description

Draw a space-time cube for a Track, TTracks, TracksCollection, difftrack or STI(DF) class.

Usage

```
## S4 method for signature 'Track'
stcube(x, xlab = "x", ylab = "y", zlab = "t", type = "l",
aspect, xlim = stbox(x)[[1]] + c(-0.1,0.1) * diff(stbox(x)[[1]]),
      ylim = stbox(x)[[2]] + c(-0.1,0.1) * diff(stbox(x)[[2]]),
zlim = stbox(x)$time, showMap = FALSE, mapType = "osm",
mapZoom = NULL, ..., y, z)
## S4 method for signature 'Tracks'
stcube(x, xlab = "x", ylab = "y", zlab = "t", type = "l",
aspect, xlim, ylim, zlim, showMap = FALSE, mapType = "osm",
normalizeBy = "week", mapZoom = NULL, ..., y, z, col)
## S4 method for signature 'TracksCollection'
stcube(x, xlab = "x", ylab = "y", zlab = "t",
type = "l", aspect, xlim, ylim, zlim, showMap = FALSE, mapType = "osm",
normalizeBy = "week", mapZoom = NULL, ..., y, z, col)
## S4 method for signature 'difftrack'
stcube(x, showMap = FALSE, mapType = "osm", normalizeBy = "week", ..., y, z)
## S4 method for signature 'STI'
stcube(x, xlab = "x", ylab = "y", zlab = "t", type = "p", aspect,
      xlim = stbox(x)[[1]] + c(-0.1,0.1) * diff(stbox(x)[[1]]),
      ylim = stbox(x)[[2]] + c(-0.1,0.1) * diff(stbox(x)[[2]]),
      zlim = stbox(x)$time,
      showMap = FALSE, mapType = "osm", mapZoom = NULL, ..., y, z)
## S4 method for signature 'STIDF'
stcube(x, xlab = "x", ylab = "y", zlab = "t", type = "p", aspect,
      xlim = stbox(x)[[1]] + c(-0.1,0.1) * diff(stbox(x)[[1]]),
      ylim = stbox(x)[[2]] + c(-0.1,0.1) * diff(stbox(x)[[2]]),
      zlim = stbox(x)$time,
      showMap = FALSE, mapType = "osm", mapZoom = NULL, col, ..., y, z)
```

Arguments

x	An object of class Track, Tracks, or TracksCollection or difftrack.
xlab, ylab, zlab, type, aspect, xlim, ylim, zlim	Arguments passed to plot3d() of package rgl.
showMap	Flag if a basemap is to be shown on the xy plane; for this to function, you may need to load library raster first, see also the stcube demo script.
mapType	The tile server from which to get the map. Passed as type to openmap() of package OpenStreetMap.

normalizeBy	An abstract time period (either week or day) to be normalized by.
mapZoom	Set a zoom level for the map used as background. Null will use the osm package default strategie.
y, z, col	Ignored, but included in the method signature for implementation reasons.
...	Additional arguments passed to plot3d() of package rgl.

Value

A space-time cube.

Examples

```
## Not run: demo(stcube)
```

storms	<i>Storm trajectories</i>
--------	---------------------------

Description

storm trajectories, 2009-2012, from <http://weather.unisys.com/hurricane/atlantic/>

Usage

```
data(storms)
```

Examples

```
data(storms)
dim(storms)
plot(storms)
x = approxTracksCollection(storms, by = "30 min", FUN = spline)
plot(x, col = 'red', add = TRUE)
## Not run:
demo(storms) # regenerates these data from their source

## End(Not run)
```

Track-class

*Classes "Track", "Tracks", and "TracksCollection"***Description**

Classes for representing sets of trajectory data, with attributes, for different IDs (persons, objects, etc)

Usage

```

Track(track, df = fn(track), fn = TrackStats)
Tracks(tracks, tracksData = data.frame(row.names=names(tracks)),
       fn = TrackSummary)
TracksCollection(tracksCollection, tracksCollectionData,
                fn = TracksSummary)
TrackStats(track)
TrackSummary(track)
TracksSummary(tracksCollection)
## S4 method for signature 'Track'
x[i, j, ..., drop = TRUE]
## S4 method for signature 'TracksCollection'
x[i, j, ..., drop = TRUE]
## S4 method for signature 'Track,data.frame'
coerce(from, to)
## S4 method for signature 'Tracks,data.frame'
coerce(from, to)
## S4 method for signature 'TracksCollection,data.frame'
coerce(from, to)

```

Arguments

track	object of class STIDF-class , representing a single trip
df	optional data.frame with information between track points
tracks	named list with Track objects
tracksData	data.frame with summary data for each Track
tracksCollection	list, with Tracks objects
tracksCollectionData	data.frame, with summary data on tracksCollection
fn	function;
x	object of class Track etc
i	selection of spatial entities
j	selection of temporal entities (see syntax in package xts)
...	selection of attribute(s)

drop	logical
from	from
to	target class

Value

Functions `Track`, `Tracks` and `TracksCollection` are constructor functions that take the slots as arguments, check object validity, and compute summary statistics on the track and tracks sets.

`TrackStats` returns a `data.frame` with for each track segment the distance, duration, speed, and direction. In case data are geographical coordinates (long/lat), distance is in m, and direction is initial bearing.

`TrackSummary` reports for each track `xmin`, `xmax`, `ymin`, `ymax`, `tmin`, `tmax`, (number of points) `n`, (total) distance, and `medspeed` (median speed).

`TracksSummary` reports for each `Tracks` of a `TracksCollection` (number of tracks) `n`, `xmin`, `xmax`, `ymin`, `ymax`, `tmin`, `tmax`.

Objects from the Class

Objects of class `Track` extend [STIDF-class](#) and contain single trips or tracks, objects of class `Tracks` contain multiple `Track` objects for a single ID (person, object or tracking device), objects of class `TracksCollection` contain multiple `Tracks` objects for different IDs.

Slots of class "Track"

`sp`: spatial locations of the track points, with length `n`

`time`: time stamps of the track points

`endTime`: end time stamps of the track points

`data`: `data.frame` with `n` rows, containing attributes of the track points

`connections`: `data.frame`, with `n-1` rows, containing attributes between the track points such as distance and speed

Slots of class "Tracks"

`tracks`: list with `Track` objects, of length `m`

`tracksData`: `data.frame` with `m` rows, containing summary data for each `Track` object

Slots of class "TracksCollection"

`tracksCollection`: list `Tracks` objects, of length `p`

`tracksCollectionData`: `data.frame` with `p` rows, containing summary data for each `Tracks` object

Methods

```

[[ signature(obj = "Track"): retrieves the attribute element
[[ signature(obj = "Tracks"): retrieves the attribute element
[[ signature(obj = "TracksCollection"): retrieves the attribute element
[[<- signature(obj = "Track"): sets or replaces the attribute element
[[<- signature(obj = "Tracks"): sets or replaces the attribute element
[[<- signature(obj = "TracksCollection"): sets or replaces the attribute element
$ signature(obj = "Track"): retrieves the attribute element
$ signature(obj = "Tracks"): retrieves the attribute element
$ signature(obj = "TracksCollection"): retrieves the attribute element
$<- signature(obj = "Track"): sets or replaces the attribute element
$<- signature(obj = "Tracks"): sets or replaces the attribute element
$<- signature(obj = "TracksCollection"): sets or replaces the attribute element
coerce signature(from = Track, to = data.frame) coerce to data.frame
coerce signature(from = Tracks, to = data.frame) coerce to data.frame
coerce signature(form = TracksCollection, to = data.frame) coerce to data.frame
plot signature(x = "TracksCollection", y = "missing"): plots sets of sets of tracks
stplot signature(obj = "TracksCollection"): plots sets of sets of tracks

```

Note

segments is a data.frame form in which track segments instead of track points form a record, with x0, y0, x1 and y1 the start and end coordinates

Author(s)

Edzer Pebesma, <edzer.pebesma@uni-muenster.de>

References

<http://www.jstatsoft.org/v51/i07/>

Examples

```

library(sp)
library(spacetime)
# t0 = as.POSIXct(as.Date("2013-09-30", tz="CET"))
t0 = as.POSIXct("2013-09-30 02:00:00", tz = "Europe/Berlin")
# person A, track 1:
x = c(7,6,5,5,4,3,3)
y = c(7,7,6,5,5,6,7)
n = length(x)
set.seed(131)
t = t0 + cumsum(runif(n) * 60)
crs = CRS("+proj=longlat +datum=WGS84") # longlat

```

```

stidf = STIDF(SpatialPoints(cbind(x,y),crs), t, data.frame(co2 = rnorm(n)))
A1 = Track(stidf)
# person A, track 2:
x = c(7,6,6,7,7)
y = c(6,5,4,4,3)
n = length(x)
t = max(t) + cumsum(runif(n) * 60)
stidf = STIDF(SpatialPoints(cbind(x,y),crs), t, data.frame(co2 = rnorm(n)))
A2 = Track(stidf)
# Tracks for person A:
A = Tracks(list(A1=A1,A2=A2))
# person B, track 1:
x = c(2,2,1,1,2,3)
y = c(5,4,3,2,2,3)
n = length(x)
t = max(t) + cumsum(runif(n) * 60)
stidf = STIDF(SpatialPoints(cbind(x,y),crs), t, data.frame(co2 = rnorm(n)))
B1 = Track(stidf)
# person B, track 2:
x = c(3,3,4,3,3,4)
y = c(5,4,3,2,1,1)
n = length(x)
t = max(t) + cumsum(runif(n) * 60)
stidf = STIDF(SpatialPoints(cbind(x,y),crs), t, data.frame(co2 = rnorm(n)))
B2 = Track(stidf)
# Tracks for person A:
B = Tracks(list(B1=B1,B2=B2))
Tr = TracksCollection(list(A=A,B=B))
stplot(Tr, scales = list(draw=TRUE))
stplot(Tr, attr = "direction", arrows=TRUE, lwd = 3, by = "direction")
stplot(Tr, attr = "direction", arrows=TRUE, lwd = 3, by = "IDs")
plot(Tr, col=2, axes=TRUE)
dim(Tr)
dim(Tr[2])
dim(Tr[2][1])
u = stack(Tr) # four IDs
dim(u)
dim(unstack(u, c(1,1,2,2))) # regroups to original
dim(unstack(u, c(1,1,2,3))) # regroups to three IDs
dim(unstack(u, c(1,2,2,1))) # regroups differently
as(Tr, "data.frame")[1:10,] # tracks separated by NA rows
as(Tr, "segments")[1:10,] # track segments as records
Tr[["distance"]] = Tr[["distance"]] * 1000
Tr$distance = Tr$distance / 1000
Tr$distance
# work with custom TrackStats function:
MyStats = function(track) {
df = apply(coordinates(track@sp), 2, diff) # requires sp
data.frame(distance = apply(df, 1, function(x) sqrt(sum(x^2))))
}
crs = CRS(as.character(NA))
stidf = STIDF(SpatialPoints(cbind(x,y),crs), t, data.frame(co2 = rnorm(n)))
B2 = Track(stidf) # no longer longlat;

```

```

B3 = Track(stidf, fn = MyStats)
all.equal(B3$distance, B2$distance)

# approxTrack:
opar = par()
par(mfrow = c(1, 2))
plot(B2, ylim = c(.5, 6))
plot(B2, pch = 16, add = TRUE)
title("irregular time steps")
i = index(B2)
B3 = approxTrack(B2, seq(min(i), max(i), length.out = 50))
plot(B3, col = 'red', type = 'p', add = TRUE)
B4 = approxTrack(B2, seq(min(i), max(i), length.out = 50), FUN = spline)
plot(B4, col = 'blue', type = 'b', add = TRUE)
# regular time steps:
t = max(t) + (1:n) * 60 # regular
B2 = Track(STIDF(SpatialPoints(cbind(x,y),crs), t, data.frame(co2 = rnorm(n))))
plot(B2, ylim = c(.5, 6))
plot(B2, pch = 16, add = TRUE)
title("constant time steps")
i = index(B2)
B3 = approxTrack(B2)
plot(B3, type = 'p', col = 'red', add = TRUE)
B4 = approxTrack(B2, FUN = spline)
plot(B4, type = 'p', col = 'blue', add = TRUE)

# par(opar) # good to do, but would generate warnings
smth = function(x,y,xout,...) predict(smooth.spline(as.numeric(x), y), as.numeric(xout))
data(storms)
plot(storms, type = 'p')
storms.smooth = approxTracksCollection(storms, FUN = smth, n = 200)
plot(storms.smooth, add = TRUE, col = 'red')

```

Track.idw

Movement smoothing of trajectory pattern

Description

Movement smoothing of trajectory pattern

Usage

```
Track.idw(X,timestamp,epsilon=epsilon,...)
```

Arguments

X	a list of objects of class "Track"
timestamp	based on secs,mins, ...

epsilon (optional) movements with length less than epsilon are not considered in the calculation

... passed to arguments of function `idw` in `spatstat`

Details

Performs spatial smoothing to the movements of a list of tracks.

Value

an image of class "im".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[as.Track.arrow](#), [idw](#)

Examples

```
if (require(spatstat.geom)) {
  X <- list()
  for(i in 1:10){
    m <- matrix(c(0,10,0,10),nrow=2,byrow = TRUE)
    X[[i]] <- rTrack(bbox = m,transform = TRUE)
  }
  Track.idw(X,timestamp="180 secs")
}
```

tsqTracks

tsqTracks

Description

`tsqtracks` returns a sequence of time based on a list of tracks (or a single object of class "Track") and an argument `timestamp`.

Usage

```
tsqTracks(X,timestamp)
```

Arguments

`X` either an object of class "Track" or a list of some objects of class "Track"

`timestamp` a timestamp to create the time sequence based on it

Details

This creates a sequence of time based on a track or a list of tracks.

Value

An object of class "POSIXct" or "POSIXt".

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

rTrack

Examples

```
library(sp)
library(spacetime)
# t0 = as.POSIXct(as.Date("2013-09-30", tz="CET"))
t0 = as.POSIXct("2013-09-30 02:00:00", tz = "Europe/Berlin")
# person A, track 1:
x = c(7,6,5,5,4,3,3)
y = c(7,7,6,5,5,6,7)
n = length(x)
set.seed(131)
t = t0 + cumsum(runif(n) * 60)
crs = CRS("+proj=longlat +datum=WGS84") # longlat
stidf = STIDF(SpatialPoints(cbind(x,y),crs), t, data.frame(co2 = rnorm(n)))
A1 = Track(stidf)
tsqTracks(A1,timestamp = "1 sec")
```

unique.Track

unique.Track

Description

Removing duplicated points in a track

Usage

```
## S3 method for class 'Track'
unique(x,...)
```

Arguments

x an object of class "Track"
 ... passed to arguments of unique

Details

This function removes duplicated points in an object of class "Track".

Value

An object of class Track with no duplicated point.

Author(s)

Mohammad Mehdi Moradi <moradi@uji.es>

See Also

[rTrack](#), [rTracks](#), [rTracksCollection](#), [unique](#)

Examples

```
x <- rTrack()
unique(x)
```

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