

# Package ‘trajectories’

April 5, 2023

**Version** 0.2-7

**Title** Classes and Methods for Trajectory Data

**Depends** R (>= 3.0.0)

**Imports** stats, utils, graphics, methods, lattice, sp (>= 1.1-0),  
spacetime (>= 1.0-0), zoo

**Suggests** OpenStreetMap, RCurl, rjson, adehabitatLT, xts, knitr, rgl,  
forecast, MASS, spatstat (>= 2.0-1), spatstat.explore,  
spatstat.geom, taxidata, sf

**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.

**License** GPL (>= 2)

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

**Additional\_repositories** <http://gis-bigdata.uni-muenster.de/pebesma/>

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

**VignetteBuilder** knitr

**Collate** Class-Tracks.R Tracks-methods.R generalize.R stcube.R stplot.R  
difftrack.R compare-methods.R rtracks.R Trackstat.R

**RoxygenNote** 6.0.1

**NeedsCompilation** no

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**Repository** CRAN

**Date/Publication** 2023-04-05 21:00:02 UTC

**R topics documented:**

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---

A3 *Trajectory*

---

**Description**

Trajectory, locally stored, from envirocar.org, see example below how it was imported

**Usage**

```
data(A3)
```

**Examples**

```
library(spacetime)
data(A3)
dim(A3)
# see demo(A3) to see how A3 was fetched, and created from the web service
```

---

`as.list.Tracks` *as.list.Tracks*

---

**Description**

Convert a "Tracks" object to a list of tracks

**Usage**

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

**Arguments**

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

**Author(s)**

Mohammad Mehdi Moradi <moradi@uji.es>

**See Also**

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

**Examples**

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

```
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**

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

**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 <a href="#">cut</a>
...	passed down to Tracks and Track methods, then to <a href="#">cut</a>
include.lowest	see <a href="#">cut</a>
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

```

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

## space-time cube of the difftrack
## Not run:
  stcube(difftrack)

## End(Not run)
```

---

dists	<i>Calculate distances between two Tracks objects</i>
-------	---

---

### Description

Calculates a distance matrix with distances for each pair of tracks.

### Usage

```
## S4 method for signature 'Tracks,Tracks'
dists(tr1, tr2, f, ...)
```

### Arguments

tr1	An object of class Tracks.
tr2	An object of class Tracks.
f	A function to calculate distances. Default is mean.
...	Additional parameters passed to f.

### Details

f can be any function applicable to a numerical vector or [frechetDist](#).

### Value

A matrix with distances between each pair of tracks or NA if they don't overlap in time.

### 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
```

```
## 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/Fr'echet\\_distance](http://en.wikipedia.org/wiki/Fr'echet_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 <a href="#">st_simplify</a> , to generalize segments using the Douglas-Peucker algorithm.
toPoints	keep mid point rather than forming <a href="#">SpatialLines</a> 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 &lt;moradi@uji.es&gt;

---

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 objetos 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. `bbox` gives a matrix with coordinate min/max values, compatible to [bbox](#)

**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, TRacks, 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

*Storm trajectories*

---

**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 <a href="#">STIDF-class</a> , 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 Track,data.framecoerce to data.frame
coerce Tracks,data.framecoerce to data.frame
coerce TracksCollection,data.framecoerce 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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