

# Package ‘SDLfilter’

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**Type** Package

**Title** Filtering Satellite-Derived Locations

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**Description** Functions to filter GPS and/or Argos locations. The provided filters remove temporal and spatial duplicates, fixes located at a given height from estimated high tide line, and locations with high error as proposed in Shimada et al. (2012) <doi:10.3354/meps09747> and Shimada et al. (2016) <doi:10.1007/s00227-015-2771-0>.

**Depends** R (>= 2.10), ggplot2

**Imports** sp, raster, trip, data.table, geosphere, ggmap, gridExtra, ggsn, stats, maps

**License** GPL-2 | file LICENSE

**URL** <https://github.com/TakahiroShimada/SDLfilter>

**BugReports** <https://github.com/TakahiroShimada/SDLfilter/issues>

**LazyData** true

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**RoxygenNote** 6.1.1

**NeedsCompilation** no

**Repository** CRAN

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Australia	<i>A map of Australia</i>
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**Description**

This map layer outlines the coast of Australia.

**Usage**

Australia

**Format**

A data.frame

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bathymodel	<i>Bathymetry model for Sandy Strait, Australia</i>
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**Description**

A high resolution bathymetry model (100 m) for the Sandy Strait region developed by Beaman, R.J. (2010).

**Usage**

bathymodel

**Format**

A RasterLayer

**Source**

<https://www.deepreef.org/>

**References**

Beaman, R.J. (2010) Project 3DGBR: A high-resolution depth model for the Great Barrier Reef and Coral Sea. Marine and Tropical Sciences Research Facility (MTSRF) Project 2.5i.1a Final Report, MTSRF, Cairns, Australia, pp. 13 plus Appendix 1.

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 ddfilter

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*Filter locations using a data driven filter*


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**Description**

Function to remove locations by a data driven filter as described in Shimada et al. (2012)

**Usage**

```
ddfilter(sdata, vmax = 8.9, maxvlp = 1.8, qi = 4, ia = 90,
         method = 2)
```

**Arguments**

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class POSIXct. "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
vmax	A numeric vector specifying threshold speed both from a previous and to a subsequent fix. Default is 8.9km/h. If this value is unknown, the function "est.vmax" can be used to estimate the value based on the supplied data.
maxvlp	A numeric value specifying threshold speed during a loop trip. Default is 1.8 km/h. If this value is unknown, the function "est.maxvlp" can be used to estimate the value based on the supplied data.
qi	An integer specifying threshold quality index during a loop trip. Default is 4.
ia	An integer specifying threshold inner angle during a loop trip. Default is 90 degrees.
method	An integer specifying how locations are filtered by speed. 1 = a location is removed if the speed EITHER from a previous and to a subsequent location exceeds a given threshold speed. 2 = a location is removed if the speed BOTH from a previous and to a subsequent location exceeds a given threshold speed. Default is 2.

## Details

Locations are removed if the speed both from a previous and to a subsequent location exceeds a given "vmax", or if all of the following criteria apply: the associated quality index is less than or equal to a given "qi", the inner angle is less than or equal to a given "ia" and the speed either from a previous or to a subsequent location exceeds a given "maxvlp". If "vmax" and "maxvlp" are unknown, they can be estimated using the functions "est.vmax" and "est.maxvlp", respectively.

## Value

A data frame is returned without locations identified by this filter. The following columns are added: "pTime", "sTime", "pDist", "sDist", "pSpeed", "sSpeed", "inAng". "pTime" and "sTime" are hours from a previous and to a subsequent fix respectively. "pDist" and "sDist" are straight distances in kilometres from a previous and to a subsequent fix respectively. "pSpeed" and "sSpeed" are linear speed from a previous and to a subsequent fix respectively. "inAng" is the angle between the bearings of lines joining successive location points.

## Author(s)

Takahiro Shimada

## References

Shimada T, Jones R, Limpus C, Hamann M (2012) Improving data retention and home range estimates by data-driven screening. *Marine Ecology Progress Series* 457:171-180 doi:10.3354/meps09747

## See Also

[ddfilter.speed](#), [ddfilter.loop](#), [est.vmax](#), [est.maxvlp](#)

## Examples

```
#### Load data sets
## Fastloc GPS data obtained from a green turtle
data(turtle)

## A Map for the example site
data(Australia)
data(SandyStrait)

#### Filter temporal and/or spatial duplicates
turtle.dup <- dupfilter(turtle, step.time=5/60, step.dist=0.001)

#### ddfilter
## Using the built-in function to estimate the threshold speeds
V <- est.vmax(turtle.dup)
VLP <- est.maxvlp(turtle.dup)
turtle.dd <- ddfilter(turtle.dup, vmax=V, maxvlp=VLP)

## Or using user specified threshold speeds
```

```

turtle.dd <- ddfilter(turtle.dup, vmax=9.9, qi=4, ia=90, maxvlp=2.0)

#### Plot data removed or retained by ddfilter
## Entire area
p1<-plotMap(turtle.dup, bgmap=Australia, point.size = 2, line.size = 0.5, axes.lab.size = 0,
            sb.distance=200, multiplot = FALSE, point.bg = "red",
            title.size=15, title="Entire area")[[1]] +
  geom_point(aes(x=lon, y=lat), data=turtle.dd, size=2, fill="yellow", shape=21)+
  geom_point(aes(x=x, y=y), data=data.frame(x=c(154, 154), y=c(-22, -22.5)),
            size=3, fill=c("yellow", "red"), shape=21) +
  annotate("text", x=c(154.3, 154.3), y=c(-22, -22.5), label=c("Retained", "Removed"),
         colour="black", size=4, hjust = 0)

## Zoomed in
p2<-plotMap(turtle.dup, bgmap=SandyStrait, xlim=c(152.7, 153.2), ylim=(c(-25.75, -25.24)),
            axes.lab.size = 0, sb.distance=10, point.size = 2, point.bg = "red", line.size = 0.5,
            multiplot = FALSE, title.size=15, title="Zoomed in")[[1]] +
  geom_path(aes(x=lon, y=lat), data=turtle.dd, size=0.5, colour="black", linetype=1) +
  geom_point(aes(x=lon, y=lat), data=turtle.dd, size=2, colour="black", shape=21, fill="yellow")

gridExtra::marrangeGrob(list(p1, p2), nrow=1, ncol=2)

```

ddfilter.loop

*Filter locations by quality index, inner angle, and speed***Description**

A partial component of ddfilter, although works as a stand-alone function. This function removes locations by speed, inner angle, and quality index as described in Shimada et al. (2012).

**Usage**

```
ddfilter.loop(sdata, qi = 4, ia = 90, maxvlp = 1.8)
```

**Arguments**

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
qi	An integer specifying threshold quality index during a loop trip. Default is 4 satellites.
ia	An integer specifying threshold inner angle during a loop trip. Default is 90 degrees.
maxvlp	A numeric value specifying threshold speed during a loop trip. Default is 1.8 km/h. If this value is unknown, the function "est.maxvlp" can be used to estimate the value based on the supplied data.

## Details

This function removes locations if all of the following criteria apply: the number of source satellites are less than or equal to "qi", the inner angle is less than and equal to "ia" and the speed either from a previous or to a subsequent location exceeds "maxvlp". If "maxvlp" is unknown, it can be estimated using the function "est.maxvlp".

## Value

A data frame is returned without locations identified by this filter. The following columns are added: "pTime", "sTime", "pDist", "sDist", "pSpeed", "sSpeed", "inAng". "pTime" and "sTime" are hours from a previous and to a subsequent fix respectively. "pDist" and "sDist" are straight distances in kilometres from a previous and to a subsequent fix respectively. "pSpeed" and "sSpeed" are linear speed from a previous and to a subsequent fix respectively. "inAng" is the angle between the bearings of lines joining successive location points.

## Author(s)

Takahiro Shimada

## References

Shimada T, Jones R, Limpus C, Hamann M (2012) Improving data retention and home range estimates by data-driven screening. *Marine Ecology Progress Series* 457:171-180 doi:10.3354/meps09747

## See Also

[ddfilter](#), [ddfilter.speed](#), [est.maxvlp](#)

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ddfilter.speed

*Filter locations by speed*

---

## Description

A partial component of ddfilter, although works as a stand-alone function. This function removes locations by a given threshold speed as described in Shimada et al. (2012).

## Usage

```
ddfilter.speed(sdata, vmax = 8.9, method = 2)
```

## Arguments

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
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vmax	A numeric value specifying threshold speed both from a previous and to a subsequent fix. Default is 8.9 km/h. If this value is unknown, the function "est.vmax" can be used to estimate the value based on the supplied data.
method	An integer specifying how locations are filtered by speed. 1 = a location is removed if the speed EITHER from a previous and to a subsequent location exceeds a given threshold speed. 2 = a location is removed if the speed BOTH from a previous and to a subsequent location exceeds a given threshold speed. Default is FALSE.

### Details

This function removes locations if the speed both/either from a previous and to a subsequent location exceeds a given threshold speed. If "vmax" is unknown, it can be estimated using the function "est.vmax".

### Value

A data frame is returned without locations identified by this filter. The following columns are added: "pTime", "sTime", "pDist", "sDist", "pSpeed", "sSpeed". "pTime" and "sTime" are hours from a previous and to a subsequent fix respectively. "pDist" and "sDist" are straight distances in kilometres from a previous and to a subsequent fix respectively. "pSpeed" and "sSpeed" are linear speed from a previous and to a subsequent fix respectively.

### Author(s)

Takahiro Shimada

### References

Shimada T, Jones R, Limpus C, Hamann M (2012) Improving data retention and home range estimates by data-driven screening. *Marine Ecology Progress Series* 457:171-180 doi:10.3354/meps09747

### See Also

[ddfiter](#), [ddfiter.loop](#), [est.vmax](#)

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depthfilter

*Filter locations by water depth*

---

### Description

Function to remove fixes located at a given height from the high tide line.

### Usage

```
depthfilter(sdata, bathymetry, extract = "bilinear", tide, qi = 4,
  depth = 0, tidal.plane, filter = TRUE)
```

**Arguments**

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
bathymetry	object of class "RasterLayer" containing bathymetric data in meters. Geographic coordinate system is WGS84.
extract	Method to extract cell values from raster layer inherited from extract function of the raster package. Default is "bilinear". See <a href="#">extract</a> for details.
tide	A data frame containing columns with the following headers: "tideDT", "reading", "standard.port". "tideDT" is date & time in class <code>POSIXct</code> for each observed tidal height. "reading" is the observed tidal height in meters. "standard.port" is the identifier of each tidal station.
qi	An integer specifying threshold quality index. Fixes associated to a quality index higher than the threshold are excluded from the depthfilter. Default is 4
depth	An integer denoting vertical difference from a high tide line in meters. A positive value indicates above the high tide and a negative value indicates below the high tide. The function removes fixes above the given threshold. Default is 0 m (i.e. high tide line).
tidal.plane	A data frame containing columns with the following headers: "standard.port", "secondary.port", "lat", "lon", "timeDiff", "datumDiff". "standard.port" is the identifier for a tidal observation station. "secondary.port" is the identifier for a station at which tide is only predicted using tidal records observed at the related standard port. "lat" and "lon" are the latitude and longitude of each secondary port in decimal degrees. "timeDiff" is the time difference between standard port and its associated secondary port. "datumDiff" is the baseline difference in meters between bathymetry and tidal observations/predictions if each data uses different datum (e.g. LAT and MSL).
filter	Default is TRUE. If FALSE, the function does not filter locations but the depth estimates are returned.

**Details**

This function removes fixes located at a given height from estimated high tide line when the "filter" option is enabled. The function chooses the closest match between each fix and tidal observations or predictions in temporal and spatial scales in order to estimate height of high tide at the time and location of each fix. It does not filter data when the "filter" option is disabled but it returns the estimated water depth of each location with the tide effect accounted for (bathymetry + tide). The estimated water depths are returned in the "depth.exp" column.

**Value**

Input data is returned with two columns added; "depth.exp", "depth.HT". "depth.exp" is the estimated water depth at the time of location fixing. "depth.HT" is the estimated water depth at the



high tide nearest to the time and location of each fix. When the "filter" option is enabled, the fixes identified by this filter are removed from the input data.

**Note**

Input data must not contain temporal or spatial duplicates.

**Author(s)**

Takahiro Shimada

**References**

Shimada T, Limpus C, Jones R, Hazel J, Groom R, Hamann M (2016) Sea turtles return home after intentional displacement from coastal foraging areas. *Marine Biology* 163:1-14 doi:10.1007/s00227-015-2771-0

Beaman, R.J. (2010) Project 3DGBR: A high-resolution depth model for the Great Barrier Reef and Coral Sea. Marine and Tropical Sciences Research Facility (MTRSF) Project 2.5i.1a Final Report, MTRSF, Cairns, Australia, pp. 13 plus Appendix 1.

**See Also**

[dupfilter](#), [ddfiter](#)

**Examples**

```
#### Load data sets
## Fastloc GPS data obtained from a green turtle
data(turtle)

## Bathymetry model developed by Beaman (2010)
data(bathymodel)

## A tidal plane for the example site
data(tidalplane)

## Tidal observations and predictions for the example site
data(tidedata)

## Maps for the example site
data(SandyStrait)

#### Remove temporal and/or spatial duplicates
turtle.dup <- dupfilter(turtle)

#### Remove biologically unrealistic fixes
turtle.dd <- ddfilter(turtle.dup, vmax=9.9, qi=4, ia=90, maxvlp=2.0)
```

```
#### Apply depthfilter
turtle.dep <- depthfilter(sdata=turtle.dd,
                          bathymetry=bathymodel,
                          tide=tidedata,
                          tidal.plane=tidalplane)

#### Plot data removed or retained by depthfilter
plotMap(turtle.dd, bgmap=SandyStrait, point.bg = "red", point.size = 2, line.size = 0.5,
        axes.lab.size = 0, title.size=0, sb.distance=10, multiplot = FALSE)[[1]] +
  geom_point(aes(x=lon, y=lat), data=turtle.dep, size=2, fill="yellow", shape=21)+
  geom_point(aes(x=x, y=y), data=data.frame(x=c(152.68, 152.68), y=c(-25.3, -25.34)),
            size=3, fill=c("yellow", "red"), shape=21) +
  annotate("text", x=c(152.7, 152.7), y=c(-25.3, -25.34), label=c("Retained", "Removed"),
        colour="black", size=4, hjust = 0)
```

---

distance\_filter      *Filter locations by distance*

---

### Description

This function removes locations that are located beyond a given threshold distance.

### Usage

```
distance_filter(sdata, distance1 = 100, distance2 = 100, method = 2)
```

### Arguments

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
distance1	A numeric value specifying threshold distance from a previous fix. Default is 100 km.
distance2	A numeric value specifying threshold distance to a subsequent fix. Default is 100 km.
method	An integer specifying how locations are filtered by distance. 1 = a location is removed if the distance EITHER from a previous and to a subsequent location exceeds a given threshold speed. 2 = a location is removed if the distance BOTH from a previous and to a subsequent location exceeds a given threshold speed. Default is FALSE.

**Details**

This function removes locations if the distance both/either from a previous and to a subsequent location exceeds a given threshold distance.

**Value**

A data frame is returned without locations identified by this filter. The following columns are added: "pTime", "pDist". "pTime" is hours from a previous fix. "pDist" is straight distance in kilometres from a previous fix.

**Author(s)**

Takahiro Shimada

---

dupfilter	<i>Filter temporal and/or spatial duplicates</i>
-----------	--

---

**Description**

Function to remove temporal and/or spatial duplicates.

**Usage**

```
dupfilter(sdata, step.time = 0, step.dist = 0, conditional = FALSE)
```

**Arguments**

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
step.time	A numeric value specifying temporal interval between two consecutive locations. Default is 0 hours. Locations are considered temporal duplicates if the temporal interval is less than or equal to the user specified value.
step.dist	A numeric value specifying spatial interval between two consecutive locations. Default is 0 kilometres. Locations are considered spatial duplicates if the spatial interval is less than or equal to the user specified value.
conditional	If TRUE, spatial duplicates are removed only if temporal interval between the locations is less than the time specified in "step.time". Default is FALSE.

**Details**

A fix associated with a higher quality index is retained over other duplicated fixes. If temporal duplicates are associated with same quality index, a fix located closest to a previous and a subsequent location is retained.

**Value**

Input data frame is returned with spatial and temporal duplicates removed. The following columns are added: "pTime", "sTime", "pDist", "sDist". "pTime" and "sTime" are hours from a previous and to a subsequent fix respectively. "pDist" and "sDist" are straight distances in kilometres from a previous and to a subsequent fix respectively.

**Author(s)**

Takahiro Shimada

**References**

Shimada T, Limpus C, Jones R, Hazel J, Groom R, Hamann M (2016) Sea turtles return home after intentional displacement from coastal foraging areas. *Marine Biology* 163:1-14 doi:10.1007/s00227-015-2771-0

**See Also**

[dupfilter.exact](#), [dupfilter.qi](#), [dupfilter.time](#), [dupfilter.space](#)

**Examples**

```
#### Load data sets
## Fastloc GPS data obtained from a green turtle
data(turtle)

#### Apply dupfilter
turtle.dup <- dupfilter(turtle)
```

---

`dupfilter.exact`      *Filter temporally and spatially exact duplicates*

---

**Description**

A partial component of dupfilter, although works as a stand-alone function. This function removes temporally and spatially exact duplicates.

**Usage**

```
dupfilter.exact(sdata)
```

**Arguments**

`sdata` A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class `POSIXct`. "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).

**Details**

This function selects a fix from multiple fixes, which were simultaneously obtained at the same geographical coordinate.

**Value**

Input data frame is returned with temporally and spatially exact duplicates removed. The following columns are added: "pTime", "sTime", "pDist", "sDist". "pTime" and "sTime" are hours from a previous and to a subsequent fix respectively. "pDist" and "sDist" are straight distances in kilometres from a previous and to a subsequent fix respectively.

**Author(s)**

Takahiro Shimada

**References**

Shimada T, Limpus C, Jones R, Hazel J, Groom R, Hamann M (2016) Sea turtles return home after intentional displacement from coastal foraging areas. *Marine Biology* 163:1-14 doi:10.1007/s00227-015-2771-0

**See Also**

[dupfilter](#), [dupfilter.qi](#), [dupfilter.time](#), [dupfilter.space](#)

---

dupfilter.qi

*Filter temporal duplicates by quality index*

---

**Description**

A partial component of `dupfilter`, although works as a stand-alone function. This function removes temporal duplicates according to the associated quality index.

**Usage**

```
dupfilter.qi(sdata, step.time = 0)
```

### Arguments

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
step.time	A numeric value specifying temporal interval between two consecutive locations. Default is 0 hours. Locations are considered temporal duplicates if the temporal interval is less than or equal to the user specified value.

### Details

This function selects a fix from multiple fixes, which were simultaneously obtained but associated with a different level of quality index. The fix with the higher quality index is selected over the others.

### Value

Input data frame is returned with temporal duplicates removed according to quality index. The following columns are added: "pTime", "sTime". "pTime" and "sTime" are hours from a previous and to a subsequent fix respectively.

### Author(s)

Takahiro Shimada

### References

Shimada T, Limpus C, Jones R, Hazel J, Groom R, Hamann M (2016) Sea turtles return home after intentional displacement from coastal foraging areas. *Marine Biology* 163:1-14 doi:10.1007/s00227-015-2771-0

### See Also

[dupfilter](#), [dupfilter.exact](#), [dupfilter.time](#), [dupfilter.space](#)

---

dupfilter.space

*Filter spatial duplicates*

---

### Description

A partial component of dupfilter although works as a stand-alone function. This function removes spatial duplicates.

## Usage

```
dupfilter.space(sdata, step.time = 0, step.dist = 0,  
               conditional = FALSE)
```

## Arguments

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
step.time	A numeric value specifying temporal interval between two consecutive locations. Default is 0 hours. Locations are considered temporal duplicates if the temporal interval is less than or equal to the user specified value.
step.dist	A numeric value specifying spatial interval between two consecutive locations. Default is 0 kilometres. Locations are considered spatial duplicates if the spatial interval is less than or equal to the user specified value.
conditional	If TRUE, spatial duplicates are removed only if the temporal interval between the locations is less than the time specified in "step.time". Default is FALSE.

## Details

This function selects a fix from multiple fixes which were obtained at the same geographical coordinate. A minimum of two locations per id is required to run this function.

## Value

Input data frame is returned with spatial duplicates removed. The following columns are added: "pTime", "sTime", "pDist", "sDist". "pTime" and "sTime" are hours from a previous and to a subsequent fix respectively. "pDist" and "sDist" are straight distances in kilometres from a previous and to a subsequent fix respectively.

## Author(s)

Takahiro Shimada

## References

Shimada T, Limpus C, Jones R, Hazel J, Groom R, Hamann M (2016) Sea turtles return home after intentional displacement from coastal foraging areas. *Marine Biology* 163:1-14 doi:10.1007/s00227-015-2771-0

## See Also

[dupfilter](#), [dupfilter.exact](#), [dupfilter.time](#), [dupfilter.qi](#)

---

dupfilter.time      *Filter temporal duplicates*

---

### Description

A partial component of dupfilter, although works as a stand-alone function. This function removes temporal duplicates.

### Usage

```
dupfilter.time(sdata, step.time = 0)
```

### Arguments

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
step.time	A numeric value specifying temporal interval between two consecutive locations. Default is 0 hours. Locations are considered temporal duplicates if the temporal interval is less than or equal to the user specified value.

### Details

This function removes temporal duplicates according to the total distance from a previous and to a subsequent location. A fix with a shorter sum distance is retained.

### Value

Input data frame is returned with temporal duplicates removed according to total distance from a previous and to a subsequent location. The following columns are added: "pTime", "sTime". "pTime" and "sTime" are hours from a previous and to a subsequent fix respectively.

### Author(s)

Takahiro Shimada

### References

Shimada T, Limpus C, Jones R, Hazel J, Groom R, Hamann M (2016) Sea turtles return home after intentional displacement from coastal foraging areas. *Marine Biology* 163:1-14 doi:10.1007/s00227-015-2771-0

### See Also

[dupfilter](#), [dupfilter.exact](#), [dupfilter.qi](#), [dupfilter.space](#)



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`est.maxvlp`*Estimate maximum one-way linear speed of a loop trip*

---

### Description

This function estimates the maximum one-way linear speed of a loop trip as described in Shimada et al. (2012).

### Usage

```
est.maxvlp(sdata, qi = 4, prob = 0.99)
```

### Arguments

<code>sdata</code>	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
<code>qi</code>	An integer specifying the minimum quality index associated with a location used for the estimation. Default is 4.
<code>prob</code>	A numeric value specifying a probability to obtain sample quantiles. Default is 0.99.

### Details

The function first detects a "loop trip". Loop trip behaviour is represented by spatial departure and return with more than 3 consecutive locations (Shimada et al 2012). It then calculates the net (i.e. straight-line) distance between the departure and turning location as well as the turning and return location of the loop trip, and from that calculated the net speed in and out. It discards extreme values based on the quantile specified by a user (default is 0.99). This is to exclude outliers potentially contained in the original data set. The maximum value in the retained dataset (i.e. without outliers) represents the maximum one-way linear speed at which an animal would travel during a loop trip. A minimum of 8 locations are required to run this function.

### Value

A vector is returned. The unit is in kilometres per hour.

### Note

Input data must not contain temporal or spatial duplicates.

### Author(s)

Takahiro Shimada

## References

Shimada T, Jones R, Limpus C, Hamann M (2012) Improving data retention and home range estimates by data-driven screening. *Marine Ecology Progress Series* 457:171-180 doi:10.3354/meps09747

## See Also

[ddfiler](#), [ddfiler.loop](#)

---

est.vmax

*Estimate maximum linear speed*

---

## Description

This function estimates the maximum linear speed between two consecutive locations as described in Shimada et al. (2012)

## Usage

```
est.vmax(sdata, qi = 5, prob = 0.99)
```

## Arguments

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon", "qi". This filter is independently applied to a subset of data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees. "qi" is the numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation).
qi	An integer specifying minimum quality index associated with a location used for the estimation. Default is 5.
prob	numeric value of a probability to obtain sample quantiles. Default is 0.99.

## Details

The function first calculates the linear speeds between each pair of two consecutive locations. It discards extreme values based on the quantile specified by a user (default is 0.99). This is to deal with outliers potentially contained in the original data set. The maximum value in the retained dataset (i.e. without outliers) represents the maximum linear speed at which an animal would travel between two consecutive locations.

## Value

A vector is returned. The unit is in kilometres per hour.

## Note

Input data must not contain temporal or spatial duplicates.

**Author(s)**

Takahiro Shimada

**References**

Shimada T, Jones R, Limpus C, Hamann M (2012) Improving data retention and home range estimates by data-driven screening. *Marine Ecology Progress Series* 457:171-180 doi:10.3354/meps09747

**See Also**

[ddfiler](#), [ddfiler.speed](#)

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 plotMap

---

*Plot location data*


---

**Description**

Function to easily plot locations on a map or a satellite image.

**Usage**

```
plotMap(sdata, xlim = NULL, ylim = NULL, margin = 10, bgmap = NULL,
        google.key = NULL, map.bg = "grey", map.col = "black",
        zoom = "auto", point.bg = "yellow", point.col = "black",
        point.symbol = 21, point.size = 1, line.col = "lightgrey",
        line.type = 1, line.size = 0.5, sb.distance = NULL, sb.lwd = 1,
        sb.line.col = "black", sb.text.size = 4, sb.text.col = "black",
        sb.space = 3, title = "id", title.size = 11, axes.text.size = 11,
        axes.lab.size = 11, multiplot = TRUE, nrow = 1, ncol = 1)
```

**Arguments**

sdata	A data frame containing columns with the following headers: "id", "DateTime", "lat", "lon". A map is created for each subset of location data grouped by the unique "id". "DateTime" is date & time in class <code>POSIXct</code> . "lat" and "lon" are the recorded latitude and longitude in decimal degrees.
xlim	Limits for x axis. If not specified, the values are determined as the maximum range of the input data with an additional margin (see <i>margin</i> ).
ylim	Limits for y axis. See <i>xlim</i> for details.
margin	Set the amount of spaces added around the periphery of the plot. The value is scaled to the plot. The smaller value increases the margin.
bgmap	A data.frame of a background map data, containing the following headers: "long", "lat", "group". If not specified, the "world" map provided by the <i>maps</i> package is used. The Google Maps ("terrain", "satellite", "roadmap", "hybrid") can also be queried.

<code>google.key</code>	If the Google Maps are queried, a valid API key (a string) needs to be specified here. See <a href="#">register_google</a> for details.
<code>map.bg</code>	Background colour of the map. This argument is ignored when any of the Google Maps is selected.
<code>map.col</code>	Outline colour of the map. This argument is ignored when any of the Google Maps is selected.
<code>zoom</code>	Map zoom for the Google Maps. See <a href="#">get_map</a> for details.
<code>point.bg</code>	The colour to fill in a symbol.
<code>point.col</code>	The colour for the outline of a symbol.
<code>point.symbol</code>	An integer or a string to specify the symbol type. See <a href="#">shape</a> for details.
<code>point.size</code>	An integer to specify the size of the symbol.
<code>line.col</code>	The colour of the line that connects consecutive points.
<code>line.type</code>	The type of the line that connects consecutive points. See <a href="#">linetype</a> for details.
<code>line.size</code>	An integer to specify the thickness (width) of the line that connects consecutive points.
<code>sb.distance</code>	An integer to specify the length of the scale bar. If not specified, approximately a quarter of the plotting range will be used.
<code>sb.lwd</code>	An integer to specify the thickness (width) of the scale bar.
<code>sb.line.col</code>	The colour of the scale bar.
<code>sb.text.size</code>	An integer to specify the text size for the scale bar.
<code>sb.text.col</code>	The colour of the text for the scale bar.
<code>sb.space</code>	Set the amount of space between the scale bar and the text for the scale bar. The value is scaled to the plot. The smaller value increases the space.
<code>title</code>	The main title for each plot. If not specified, the "id" will be used.
<code>title.size</code>	An integer to specify the size of the title.
<code>axes.text.size</code>	An integer to specify the size of the axes characters.
<code>axes.lab.size</code>	An integer to specify the size of the axes labels.
<code>multiplot</code>	Logical. If TRUE (default), multiple plots are displayed on the same page.
<code>nrow</code>	An integer to specify the number of rows in the multiple plot page.
<code>ncol</code>	An integer to specify the number of columns in the multiple plot page.

**Value**

An `arrangelist` is returned when `multiplot` is TRUE. Otherwise a list is returned.

**Author(s)**

Takahiro Shimada

**See Also**

[dupfilter](#), [ddfilter](#), [est.vmax](#), [est.maxvlp](#)

**Examples**

```
#### Load data sets
## Fastloc GPS data obtained from two green turtles
data(turtle)
data(turtle2)
turtles<-rbind(turtle, turtle2)

#### Filter temporal and/or spatial duplicates
turtle.dup <- dupfilter(turtles, step.time=5/60, step.dist=0.001)

#### ddfilter
V <- est.vmax(turtle.dup)
VLP <- est.maxvlp(turtle.dup)
turtle.dd <- ddfilter(turtle.dup, vmax=V, maxvlp=VLP)

#### Plot filtered data for each animal
## using the low-resolution world map
plotMap(turtle.dd, point.size = 2, line.size = 0.5, axes.lab.size = 0, ncol=2, nrow=1)

## Not run:
## using the high-resolution google satellite images
plotMap(turtle.dd, point.size = 2, line.size = 0.5, axes.lab.size = 0, ncol=2, nrow=1,
        bgmap = "satellite", sb.line.col = "white", sb.text.col = "white", key = "an_api_key")

## End(Not run)
```

---

SandyStrait

*A map of Sandy Strait, Australia*

---

**Description**

This map layer outlines the coast around Sandy Strait, Australia.

**Usage**

SandyStrait

**Format**

A data.frame

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tidalplane	<i>Tidal plane table for Sandy Strait, Australia</i>
------------	--

---

### Description

A semidiurnal tidal plane table containing the height of the mean tidal planes and the average tide time differences at different places within Sandy Strait.

### Usage

tidalplane

### Format

A data frame with 2 rows and 6 variables:

**secondary.port** identifier for a station at which tide is only predicted using tidal records observed at the related standard port

**standard.port** identifier for a tidal observation station

**lat** latitude in decimal degrees

**lon** longitude in decimal degrees

**datumDiff** baseline difference in meters between bathymetry and tidal observations/predictions if each data uses different datum (e.g. LAT and MSL)

**timeDiff** time difference between standard port and its associated secondary port

### Source

The State of Queensland (Department of Transport and Main Roads), Tidal planes.

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tidedata	<i>Tidal data for Sandy Strait, Australia</i>
----------	---

---

### Description

A dataset containing tidal observations recorded at Bundaberg, Australia

### Usage

tidedata

### Format

A data frame with 26351 rows and 3 variables:

**tideDT** date & time in class POSIXct for each observed tidal height

**reading** observed tidal height in meters

**standard.port** identifier of the tidal station

**Source**

The State of Queensland (Department of Transport and Main Roads), Tidal data.

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turtle	<i>Green turtle tracking data</i>
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---

**Description**

A dataset containing Fastloc GPS locations of a green turtle tracked in Sandy Strait, Australia.

**Usage**

turtle

**Format**

A data frame with 429 rows and 5 variables:

**id** identifier for each animal

**DateTime** date & time in class POSIXct

**lat** latitude in decimal degrees

**lon** longitude in decimal degrees

**qi** numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation)

**Source**

Shimada T, Jones R, Limpus C, Groom R, Hamann M (2016) Long-term and seasonal patterns of sea turtle home ranges in warm coastal foraging habitats: Implications for conservation. *Marine Ecology Progress Series* 562:163-179. doi: 10.3354/meps11972

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turtle2	<i>Green turtle tracking data 2</i>
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---

**Description**

A dataset containing Fastloc GPS locations of a green turtle tracked in Moreton Bay, Australia.

**Usage**

turtle2

**Format**

A data frame with 276 rows and 5 variables:

**id** identifier for each animal

**DateTime** date & time in class POSIXct

**lat** latitude in decimal degrees

**lon** longitude in decimal degrees

**qi** numerical quality index associated with each fix where the greater number represents better quality (e.g. number of GPS satellites used for estimation)

**Source**

Shimada T, Jones R, Limpus C, Groom R, Hamann M (2016) Long-term and seasonal patterns of sea turtle home ranges in warm coastal foraging habitats: Implications for conservation. *Marine Ecology Progress Series* 562:163-179. doi: 10.3354/meps11972



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