Package 'ssdtools'

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Version 0.3.3

Title Species Sensitivity Distributions

Description Species sensitivity distributions are
cumulative probability distributions which are fitted to
toxicity concentrations for different species as described by
Posthuma et al.(2001) <isbn:9781566705783>.
The ssdtools package uses Maximum Likelihood to fit distributions
such as the log-normal, gamma, log-logistic,
log-Gumbel, Gompertz and Weibull.
The user can provide custom distributions.
Multiple distributions can be averaged using Information Criteria.
Confidence intervals on hazard concentrations and proportions are produced by
parametric bootstrapping.

URL https://github.com/bcgov/ssdtools

BugReports https://github.com/bcgov/ssdtools/issues

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Depends R (>= 3.5)

Imports chk, fitdistrplus, abind, actuar, ggplot2, graphics, grid,
lifecycle, tibble, scales, stats, VGAM, Rcpp

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R topics documented:

`autoplot.fitdist` *Autoplot fitdist*

Description

Plots the cumulative distribution function (cdf) using the ggplot2 generic.

Usage

```
## S3 method for class 'fitdist'
autoplot(object, ...)

## S3 method for class 'fitdists'
autoplot(object, ...)

## S3 method for class 'fitdistcens'
autoplot(object, ...)
```

Arguments

`object`	The object.
`...`	Unused.

Functions

- `autoplot.fitdists`: Autoplot fitdists
- `autoplot.fitdistcens`: Autoplot fitdistcens

Examples

```
ggplot2::autoplot(boron_lnorm)
ggplot2::autoplot(boron_dists)
fluazinam_lnorm$censdata$right[3] <- fluazinam_lnorm$censdata$left[3] * 1.5
fluazinam_lnorm$censdata$left[5] <- NA
ggplot2::autoplot(fluazinam_lnorm)
```

`boron_data` *CCME Species Sensitivity Data for Boron*

Description

Species Sensitivity Data from the Canadian Council of Ministers of the Environment.

Usage

```
boron_data
```

Format

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 28 rows and 5 columns.

Details

Additional information is available from http://ceqg-rcqe.ccme.ca/download/en/324/.

The columns are as follows

Chemical The chemical (chr).

Species The species binomial name (chr).

Concentration The chemical concentration (dbl).

Units The units (chr).

Group The taxonomic group (fctr).

See Also

ccme_data

Examples

```
head(ccme_data)
```

boron_dists *fitdists for CCME Boron Data*

Description

A fitdists object for Species Sensitivity Data for Boron.

Usage

```
boron_dists
```

Format

An object of class `fitdists` of length 3.

Examples

```
boron_dists
```

boron_hc5 *Model averaged 5 hazard concentration for CCME Boron Data*

Description

A data frame of the predictions based on 10000 bootstrap.

Usage

```
boron_hc5
```

Format

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 1 rows and 6 columns.

Details

percent The percent of species affected (int).

est The estimated concentration (dbl).

se The standard error of the estimate (dbl).

lcl The lower confidence limit (dbl).

se The upper confidence limit (dbl).

dist The distribution (chr).

Examples

```
boron_hc5
```

boron_lnorm *fitdist for CCME Boron Data*

Description

A fitdist object for Species Sensitivity Data for Boron with the lnorm distribution.

Usage

```
boron_lnorm
```

Format

An object of class `fitdist` of length 17.

Examples

```
boron_lnorm
```

boron_pred *Model averaged predictions for CCME Boron Data*

Description

A data frame of the predictions based on 1,000 bootstrap iterations.

Usage

```
boron_pred
```

Format

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 99 rows and 6 columns.

Details

percent The percent of species affected (int).

est The estimated concentration (dbl).

se The standard error of the estimate (dbl).

lcl The lower confidence limit (dbl).

se The upper confidence limit (dbl).

dist The distribution (chr).

Examples

```
head(boron_pred)
```

burrIII2 *Burr Type III Two-Parameter Distribution*

Description

Probability density, cumulative distribution, inverse cumulative distribution, random sample and starting values functions.

Usage

```
dburrIII2(x, locationlog = 0, scalelog = 1, log = FALSE)

pburrIII2(q, locationlog = 0, scalelog = 1, lower.tail = TRUE, log.p = FALSE)

qburrIII2(p, locationlog = 0, scalelog = 1, lower.tail = TRUE, log.p = FALSE)

rburrIII2(n, locationlog = 0, scalelog = 1)
```

Arguments

x	A numeric vector of values.
locationlog	location on log scale parameter.
scalelog	scale on log scale parameter.
log	logical; if TRUE, probabilities p are given as log(p).
q	vector of quantiles.
lower.tail	logical; if TRUE (default), probabilities are P[X <= x],otherwise, P[X > x].
log.p	logical; if TRUE, probabilities p are given as log(p).
p	vector of probabilities.
n	number of observations.

Details

The burrIII2 distribution has been deprecated for the identical llogis distribution.

Value

A numeric vector.

See Also

llogis()

Examples

```
x <- seq(0.01, 5, by = 0.01)
plot(x, dburrIII2(x), type = "l")
```

burrIII3 *Burr Type III Three-Parameter Distribution*

Description

Density, distribution function, quantile function and random generation for the Burr Type III Three-Parameter distribution with `lshape` and `lscale` parameters.

Usage

```
dburrIII3(x, lshape1 = 0, lshape2 = 0, lscale = 0, log = FALSE)

qburrIII3(
  p,
  lshape1 = 0,
  lshape2 = 0,
  lscale = 0,
  lower.tail = TRUE,
  log.p = FALSE
)

pburrIII3(
  q,
  lshape1 = 0,
  lshape2 = 0,
  lscale = 0,
  lower.tail = TRUE,
  log.p = FALSE
)

rburrIII3(n, lshape1 = 0, lshape2 = 0, lscale = 0)

sburrIII3(x)
```

Arguments

`x`	The object.
`lshape1`	shape1 parameter on the log scale.
`lshape2`	shape2 parameter on the log scale.
`lscale`	scale parameter on the log scale.
`log`	logical; if TRUE, probabilities p are given as log(p).
`p`	vector of probabilities.
`lower.tail`	logical; if TRUE (default), probabilities are `P[X <= x]`,otherwise, `P[X > x]`.
`log.p`	logical; if TRUE, probabilities p are given as log(p).
`q`	vector of quantiles.
`n`	number of observations.

Details

The Burr 12 distribution from the actuar package is used as a base. The Burr III distribution is the distribution of 1/x where x has the Burr Type 12 distribution. refer to https://www.itl.nist.gov/div898/software/dataplot/refmar for details. The shape1, shape2, and scale paramters are on the log(scale) as these must be positive.

Value

dburrIII3 gives the density, pburrIII3 gives the distribution function, qburrIII3 gives the quantile function, and rburrIII3 generates random samples.

See Also

`actuar::dburr()`

Examples

```
x <- rburrIII3(1000)
hist(x, freq = FALSE, col = "gray", border = "white")
curve(dburrIII3(x), add = TRUE, col = "red4", lwd = 2)
```

---

ccme_data *CCME Species Sensitivity Data*

Description

Species Sensitivity Data from the Canadian Council of Ministers of the Environment. The taxonomic groups are Amphibian, Fish, Invertebrate and Plant. Plants includes freshwater algae.

Usage

```
ccme_data
```

Format

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 144 rows and 5 columns.

Details

Additional information on each of the chemicals is available from the CCME website.

Boron http://ceqg-rcqe.ccme.ca/download/en/324/

Cadmium http://ceqg-rcqe.ccme.ca/download/en/148/

Chloride http://ceqg-rcqe.ccme.ca/download/en/337/

Endosulfan http://ceqg-rcqe.ccme.ca/download/en/327/

Glyphosate http://ceqg-rcqe.ccme.ca/download/en/182/

Uranium http://ceqg-rcqe.ccme.ca/download/en/328/

Silver http://ceqg-rcqe.ccme.ca/download/en/355/

Chemical The chemical (chr).

Species The species binomial name (chr).

Conc The chemical concentration (dbl).

Group The taxonomic group (fctr).

Units The units (chr).

Examples

```
head(ccme_data)
```

`comma_signif` *Comma and Significance Formatter*

Description

By default the numeric vectors are first rounded to three significant figures. Then scales::commas is only applied to values greater than or equal to 1000 to ensure that labels are permitted to have different numbers of decimal places.

Usage

```
comma_signif(x, digits = 3, ...)
```

Arguments

`x`	A numeric vector to format.
`digits`	A whole number specifying the number of significant figures
`...`	Additional arguments passed to scales::comma.

Value

A character vector.

Examples

```
comma_signif(c(0.1, 1, 10, 1000))
scales::comma(c(0.1, 1, 10, 1000))
```

fluazinam_dists *fitdists for fitdistrplus fluazinam Data*

Description

A fitdists object for Species Sensitivity Data for Fluazinam.

Usage

```
fluazinam_dists
```

Format

An object of class `fitdistscens` (inherits from `fitdists`) of length 3.

See Also

`fitdistrplus::fluazinam()`

Examples

```
fluazinam_dists
```

fluazinam_lnorm *fitdist for CCME Boron Data*

Description

A fitdist object for Species Sensitivity Data for Boron with the lnorm distribution.

Usage

```
fluazinam_lnorm
```

Format

An object of class `fitdistcens` of length 17.

See Also

`fitdistrplus::fluazinam()`

Examples

```
fluazinam_lnorm
```

fluazinam_pred *Model averaged predictions for fluazinam*

Description

A data frame of the predictions.

Usage

```
fluazinam_pred
```

Format

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 99 rows and 6 columns.

Details

percent The percent of species affected (int).

est The estimated concentration (dbl).

se The standard error of the estimate (dbl).

lcl The lower confidence limit (dbl).

se The upper confidence limit (dbl).

dist The distribution (chr).

Examples

```
head(fluazinam_pred)
```

gamma *Gamma Distribution*

Description

Probability density, cumulative distribution, inverse cumulative distribution, random sample and starting values functions.

Usage

```
dgamma(x, shape = 1, scale = 1, log = FALSE)

pgamma(q, shape = 1, scale = 1, lower.tail = TRUE, log.p = FALSE)

qgamma(p, shape = 1, scale = 1, lower.tail = TRUE, log.p = FALSE)

rgamma(n, shape = 1, scale = 1)

sgamma(x)
```

Arguments

x	A numeric vector of values.
shape	A string of the column in data for the shape aesthetic.
scale	scale parameter.
log	logical; if TRUE, probabilities p are given as log(p).
q	vector of quantiles.
lower.tail	logical; if TRUE (default), probabilities are P[X <= x],otherwise, P[X > x].
log.p	logical; if TRUE, probabilities p are given as log(p).
p	vector of probabilities.
n	number of observations.

Value

A numeric vector.

See Also

stats::dgamma()

Examples

```
x <- seq(0.01, 5, by = 0.01)
plot(x, dgamma(x), type = "l")
```

---

geom_hcintersect *Hazard Concentration Intersection*

Description

For each x and y value, geom_hcintersect() plots the intersection.

Usage

```
geom_hcintersect(
  mapping = NULL,
  data = NULL,
  xintercept,
  yintercept,
  na.rm = FALSE,
  show.legend = NA,
  ...
)
```

Arguments

mapping	Set of aesthetic mappings created by aes() or aes_(). If specified and inherit.aes = TRUE (the default), it is combined with the default mapping at the top level of the plot. You must supply mapping if there is no plot mapping.
data	The data to be displayed in this layer. There are three options: If NULL, the default, the data is inherited from the plot data as specified in the call to ggplot(). A data.frame, or other object, will override the plot data. All objects will be fortified to produce a data frame. See fortify() for which variables will be created. A function will be called with a single argument, the plot data. The return value must be a data.frame, and will be used as the layer data. A function can be created from a formula (e.g. ~ head(.x,10)).
xintercept	The x-value for the intersect
yintercept	The y-value for the intersect.
na.rm	If FALSE, the default, missing values are removed with a warning. If TRUE, missing values are silently removed.
show.legend	logical. Should this layer be included in the legends? NA, the default, includes if any aesthetics are mapped. FALSE never includes, and TRUE always includes. It can also be a named logical vector to finely select the aesthetics to display.
...	Other arguments passed on to layer(). These are often aesthetics, used to set an aesthetic to a fixed value, like colour = "red" or size = 3. They may also be parameters to the paired geom/stat.

Examples

```
ggplot2::ggplot(boron_data, ggplot2::aes(x = Conc)) +
  geom_ssd() +
  geom_hcintersect(xintercept = 1.5, yintercept = 0.05)
```

---

geom_ssd *Plot Species Sensitivity Data*

Description

Uses the empirical cumulative density/distribution to visualize species sensitivity data.

Usage

```
geom_ssd(
  mapping = NULL,
  data = NULL,
  stat = "ssd",
  position = "identity",
```

```
  na.rm = FALSE,
  show.legend = NA,
  inherit.aes = TRUE,
  ...
)
```

Arguments

mapping	Set of aesthetic mappings created by aes() or aes_(). If specified and inherit.aes = TRUE (the default), it is combined with the default mapping at the top level of the plot. You must supply mapping if there is no plot mapping.
data	The data to be displayed in this layer. There are three options: If NULL, the default, the data is inherited from the plot data as specified in the call to ggplot(). A data.frame, or other object, will override the plot data. All objects will be fortified to produce a data frame. See fortify() for which variables will be created. A function will be called with a single argument, the plot data. The return value must be a data.frame, and will be used as the layer data. A function can be created from a formula (e.g. ~ head(.x,10)).
stat	The statistical transformation to use on the data for this layer, as a string.
position	Position adjustment, either as a string, or the result of a call to a position adjustment function.
na.rm	If FALSE, the default, missing values are removed with a warning. If TRUE, missing values are silently removed.
show.legend	logical. Should this layer be included in the legends? NA, the default, includes if any aesthetics are mapped. FALSE never includes, and TRUE always includes. It can also be a named logical vector to finely select the aesthetics to display.
inherit.aes	If FALSE, overrides the default aesthetics, rather than combining with them. This is most useful for helper functions that define both data and aesthetics and shouldn't inherit behaviour from the default plot specification, e.g. borders().
...	Other arguments passed on to layer(). These are often aesthetics, used to set an aesthetic to a fixed value, like colour = "red" or size = 3. They may also be parameters to the paired geom/stat.

Examples

```
ggplot2::ggplot(boron_data, ggplot2::aes(x = Conc)) +
  geom_ssd()
```

geom_xribbon *Ribbons Plot*

Description

For each y value, geom_xribbon displays an x interval defined by xmin and xmax.

Usage

```
geom_xribbon(
  mapping = NULL,
  data = NULL,
  stat = "identity",
  position = "identity",
  na.rm = FALSE,
  show.legend = NA,
  inherit.aes = TRUE,
  ...
)
```

Arguments

mapping	Set of aesthetic mappings created by aes() or aes_(). If specified and inherit.aes = TRUE (the default), it is combined with the default mapping at the top level of the plot. You must supply mapping if there is no plot mapping.
data	The data to be displayed in this layer. There are three options: If NULL, the default, the data is inherited from the plot data as specified in the call to ggplot(). A data.frame, or other object, will override the plot data. All objects will be fortified to produce a data frame. See fortify() for which variables will be created. A function will be called with a single argument, the plot data. The return value must be a data.frame, and will be used as the layer data. A function can be created from a formula (e.g. ~ head(.x,10)).
stat	The statistical transformation to use on the data for this layer, as a string.
position	Position adjustment, either as a string, or the result of a call to a position adjustment function.
na.rm	If FALSE, the default, missing values are removed with a warning. If TRUE, missing values are silently removed.
show.legend	logical. Should this layer be included in the legends? NA, the default, includes if any aesthetics are mapped. FALSE never includes, and TRUE always includes. It can also be a named logical vector to finely select the aesthetics to display.
inherit.aes	If FALSE, overrides the default aesthetics, rather than combining with them. This is most useful for helper functions that define both data and aesthetics and shouldn't inherit behaviour from the default plot specification, e.g. borders().

... Other arguments passed on to `layer()`. These are often aesthetics, used to set an aesthetic to a fixed value, like `colour = "red"` or `size = 3`. They may also be parameters to the paired geom/stat.

`gompertz` *Gompertz Distribution*

Description

Probability density, cumulative distribution, inverse cumulative distribution, random sample and starting values functions.

Usage

```
dgompertz(x, llocation = 0, lshape = 0, log = FALSE)

pgompertz(q, llocation = 0, lshape = 0, lower.tail = TRUE, log.p = FALSE)

qgompertz(p, llocation = 0, lshape = 0, lower.tail = TRUE, log.p = FALSE)

rgompertz(n, llocation = 0, lshape = 0)

sgompertz(x)
```

Arguments

`x`	A numeric vector of values.
`llocation`	location parameter on the log scale.
`lshape`	shape parameter on the log scale.
`log`	logical; if TRUE, probabilities p are given as log(p).
`q`	vector of quantiles.
`lower.tail`	logical; if TRUE (default), probabilities are `P[X <= x]`,otherwise, `P[X > x]`.
`log.p`	logical; if TRUE, probabilities p are given as log(p).
`p`	vector of probabilities.
`n`	number of observations.

Value

A numeric vector.

See Also

`stats::dgamma()`

Examples

```
x <- seq(0.01, 5, by = 0.01)
plot(x, dgompertz(x), type = "l")
```

is.fitdist *Is fitdist*

Description

Tests whether an object is a fitdist.

Usage

```
is.fitdist(x)
```

Arguments

x	The object.

Value

A flag.

Examples

```
is.fitdist(boron_lnorm)
is.fitdist(boron_dists)
is.fitdist(boron_dists[["lnorm"]])
```

is.fitdistcens *Is censored fitdist*

Description

Tests whether an object is a censored fitdist.

Usage

```
is.fitdistcens(x)
```

Arguments

x	The object.

Value

A flag.

Examples

```
is.fitdistcens(boron_lnorm)
is.fitdistcens(fluazinam_lnorm)
```

is.fitdists *Is fitdists*

Description

Tests whether an object is a fitdists.

Usage

```
is.fitdists(x)
```

Arguments

x	The object.

Value

A flag.

Examples

```
is.fitdists(boron_lnorm)
is.fitdists(boron_dists)
```

is.fitdistscens *Is censored fitdists*

Description

Tests whether an object is a censored fitdists.

Usage

```
is.fitdistscens(x)
```

Arguments

x	The object.

Value

A flag.

Examples

```
is.fitdistscens(boron_dists)
is.fitdistscens(fluazinam_lnorm)
is.fitdistscens(fluazinam_dists)
```

lgumbel *Log-Gumbel Distribution*

Description

Probability density, cumulative distribution, inverse cumulative distribution, random sample and starting values functions.

Usage

```
dlgumbel(x, locationlog = 0, scalelog = 1, log = FALSE)

plgumbel(q, locationlog = 0, scalelog = 1, lower.tail = TRUE, log.p = FALSE)

qlgumbel(p, locationlog = 0, scalelog = 1, lower.tail = TRUE, log.p = FALSE)

rlgumbel(n, locationlog = 0, scalelog = 1)

slgumbel(x)
```

Arguments

x	A numeric vector of values.
locationlog	location on log scale parameter.
scalelog	scale on log scale parameter.
log	logical; if TRUE, probabilities p are given as log(p).
q	vector of quantiles.
lower.tail	logical; if TRUE (default), probabilities are P[X <= x],otherwise, P[X > x].
log.p	logical; if TRUE, probabilities p are given as log(p).
p	vector of probabilities.
n	number of observations.

Value

A numeric vector.

Examples

```
x <- seq(0.01, 5, by = 0.01)
plot(x, dlgumbel(x), type = "l")
```

lnorm *Log-Normal Distribution*

Description

Probability density, cumulative distribution, inverse cumulative distribution, random sample and starting values functions.

Usage

```
dlnorm(x, meanlog = 0, sdlog = 1, log = FALSE)

plnorm(q, meanlog = 0, sdlog = 1, lower.tail = TRUE, log.p = FALSE)

qlnorm(p, meanlog = 0, sdlog = 1, lower.tail = TRUE, log.p = FALSE)

rlnorm(n, meanlog = 0, sdlog = 1)

slnorm(x)
```

Arguments

x	A numeric vector of values.
meanlog	mean on log scale parameter.
sdlog	standard deviation on log scale parameter.
log	logical; if TRUE, probabilities p are given as log(p).
q	vector of quantiles.
lower.tail	logical; if TRUE (default), probabilities are P[X <= x],otherwise, P[X > x].
log.p	logical; if TRUE, probabilities p are given as log(p).
p	vector of probabilities.
n	number of observations.

Value

A numeric vector.

See Also

stats::dlnorm()

Examples

```
x <- seq(0.01, 5, by = 0.01)
plot(x, dlnorm(x), type = "l")
```

nobs.fitdist *Number of Observations*

Description

Number of Observations

Usage

```
## S3 method for class 'fitdist'
nobs(object, ...)
```

Arguments

object	The object.
...	Unused.

Examples

```
stats::nobs(boron_lnorm)
```

nobs.fitdistcens *Number of Observations*

Description

Number of Observations

Usage

```
## S3 method for class 'fitdistcens'
nobs(object, ...)
```

Arguments

object	The object.
...	Unused.

Examples

```
stats::nobs(fluazinam_lnorm)
```

`npars` *Get the Number of Parameters*

Description

Get the Number of Parameters

Usage

```
npars(x, ...)

## S3 method for class 'fitdist'
npars(x, ...)

## S3 method for class 'fitdistcens'
npars(x, ...)

## S3 method for class 'fitdists'
npars(x, ...)
```

Arguments

`x`	The object.
`...`	Unused.

Value

A count indicating the number of parameters.

Methods (by class)

- `fitdist`: Get the Number of parameters
- `fitdistcens`: Get the Number of parameters
- `fitdists`: Get the Number of parameters

Examples

```
npars(boron_lnorm)
npars(boron_dists)
npars(fluazinam_lnorm)
npars(fluazinam_dists)
```

pareto *Pareto Distribution*

Description

Probability density, cumulative distribution, inverse cumulative distribution, random sample and starting values functions.

Usage

```
dpareto(x, scale = 1, shape = 1, log = FALSE)

qpareto(p, scale = 1, shape = 1, lower.tail = TRUE, log.p = FALSE)

ppareto(q, scale = 1, shape = 1, lower.tail = TRUE, log.p = FALSE)

rpareto(n, scale = 1, shape = 1)

spareto(x)
```

Arguments

x	A numeric vector of values.
scale	scale parameter.
shape	A string of the column in data for the shape aesthetic.
log	logical; if TRUE, probabilities p are given as log(p).
p	vector of probabilities.
lower.tail	logical; if TRUE (default), probabilities are P[X <= x],otherwise, P[X > x].
log.p	logical; if TRUE, probabilities p are given as log(p).
q	vector of quantiles.
n	number of observations.

Details

The pareto distribution has been deprecated as it is not suitable for SSD data. The functions are wrappers on the equivalent VGAM functions.

Value

A numeric vector.

See Also

VGAM::dpareto()

Examples

```
x <- seq(0.01, 5, by = 0.01)
plot(x, dpareto(x), type = "l")
```

`predict.fitdist` *Predict fitdist*

Description

Predict fitdist

Usage

```
## S3 method for class 'fitdist'
predict(
  object,
  percent = 1:99,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  ...
)
```

Arguments

`object`	The object.
`percent`	A numeric vector of percentages.
`ci`	A flag specifying whether to estimate confidence intervals (by parametric bootstrapping).
`level`	A number between 0 and 1 of the confidence level.
`nboot`	A count of the number of bootstrap samples to use to estimate the se and confidence limits.
`parallel`	A string specifying the type of parallel operation to be used ('no', 'snow' or 'multicore').
`ncpus`	A count of the number of parallel processes to use.
`...`	Unused.

Examples

```
predict(boron_lnorm, percent = c(5L, 50L))
```

`predict.fitdistcens` *Predict censored fitdist*

Description

Predict censored fitdist

Usage

```
## S3 method for class 'fitdistcens'
predict(
  object,
  percent = 1:99,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  ...
)
```

Arguments

`object`	The object.
`percent`	A numeric vector of percentages.
`ci`	A flag specifying whether to estimate confidence intervals (by parametric bootstrapping).
`level`	A number between 0 and 1 of the confidence level.
`nboot`	A count of the number of bootstrap samples to use to estimate the se and confidence limits.
`parallel`	A string specifying the type of parallel operation to be used ('no', 'snow' or 'multicore').
`ncpus`	A count of the number of parallel processes to use.
`...`	Unused.

Examples

```
predict(fluazinam_lnorm, percent = c(5L, 50L))
```

predict.fitdists *Predict fitdists*

Description

Predict fitdists

Usage

```
## S3 method for class 'fitdists'
predict(
  object,
  percent = 1:99,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  average = TRUE,
  ic = "aicc",
  ...
)
```

Arguments

object	The object.
percent	A numeric vector of percentages.
ci	A flag specifying whether to estimate confidence intervals (by parametric bootstrapping).
level	A number between 0 and 1 of the confidence level.
nboot	A count of the number of bootstrap samples to use to estimate the se and confidence limits.
parallel	A string specifying the type of parallel operation to be used ('no', 'snow' or 'multicore').
ncpus	A count of the number of parallel processes to use.
average	A flag specifying whether to model average the estimates.
ic	A string specifying which information-theoretic criterion ('aic', 'aicc' or 'bic') to use for model averaging .
...	Unused.

Examples

```
predict(boron_dists)
```

`predict.fitdistscens` *Predict censored fitdists*

Description

Predict censored fitdists

Usage

```
## S3 method for class 'fitdistscens'
predict(
  object,
  percent = 1:99,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  average = TRUE,
  ic = "aic",
  ...
)
```

Arguments

`object`	The object.
`percent`	A numeric vector of percentages.
`ci`	A flag specifying whether to estimate confidence intervals (by parametric bootstrapping).
`level`	A number between 0 and 1 of the confidence level.
`nboot`	A count of the number of bootstrap samples to use to estimate the se and confidence limits.
`parallel`	A string specifying the type of parallel operation to be used ('no', 'snow' or 'multicore').
`ncpus`	A count of the number of parallel processes to use.
`average`	A flag specifying whether to model average the estimates.
`ic`	A string specifying which information-theoretic criterion ('aic', 'aicc' or 'bic') to use for model averaging .
`...`	Unused.

Examples

```
predict(fluazinam_dists)
```

sburrIII2 *Log-Logistic Distribution*

Description

Probability density, cumulative distribution, inverse cumulative distribution, random sample and starting values functions.

Usage

```
sburrIII2(x)

dllog(x, locationlog = 0, scalelog = 1, log = FALSE)

qllog(p, locationlog = 0, scalelog = 1, lower.tail = TRUE, log.p = FALSE)

pllog(q, locationlog = 0, scalelog = 1, lower.tail = TRUE, log.p = FALSE)

rllog(n, locationlog = 0, scalelog = 1)

sllog(x)

dllogis(x, locationlog = 0, scalelog = 1, log = FALSE)

pllogis(q, locationlog = 0, scalelog = 1, lower.tail = TRUE, log.p = FALSE)

qllogis(p, locationlog = 0, scalelog = 1, lower.tail = TRUE, log.p = FALSE)

rllogis(n, locationlog = 0, scalelog = 1)

sllogis(x)
```

Arguments

x	A numeric vector of values.
locationlog	location on log scale parameter.
scalelog	scale on log scale parameter.
log	logical; if TRUE, probabilities p are given as log(p).
p	vector of probabilities.
lower.tail	logical; if TRUE (default), probabilities are P[X <= x],otherwise, P[X > x].
log.p	logical; if TRUE, probabilities p are given as log(p).
q	vector of quantiles.
n	number of observations.

Details

The llog distribution has been deprecated for the identical llogis distribution.

Value

A numeric vector.

See Also

stats::dlogis()

Examples

```
x <- seq(0.01, 5, by = 0.01)
plot(x, dllogis(x), type = "l")
```

---

ssdtools-ggproto *Base ggproto classes for ggplot2*

Description

Base ggproto classes for ggplot2

See Also

ggplot2::ggplot2-ggproto()

---

ssd_ecd *Empirical Cumulative Density*

Description

Empirical Cumulative Density

Usage

```
ssd_ecd(x, ties.method = "first")
```

Arguments

x	a numeric, complex, character or logical vector.
ties.method	a character string specifying how ties are treated, see 'Details'; can be abbreviated.

Value

A numeric vector of the empirical cumulative density.

Examples

```
ssd_ecd(1:10)
```

`ssd_exposure` *Percent Exposure*

Description

Calculates average proportion exposed based on log-normal distribution of concentrations.

Usage

```
ssd_exposure(x, meanlog = 0, sdlog = 1, nboot = 1000)
```

Arguments

`x`	The object.
`meanlog`	A number of the mean of the exposure concentrations on the log scale.
`sdlog`	A number of the standard deviation of the exposure concentrations on the log scale.
`nboot`	The number of samples to use to calculate the exposure.

Value

A number of the proportion exposed.

Examples

```
set.seed(10)
ssd_exposure(boron_lnorm)
ssd_exposure(boron_lnorm, meanlog = 1)
ssd_exposure(boron_lnorm, meanlog = 1, sdlog = 1)
```

`ssd_fit_dists` *Fit Distributions*

Description

Fits one or more distributions to species sensitivity data.

Usage

```
ssd_fit_dists(
  data,
  left = "Conc",
  right = left,
  weight = NULL,
  dists = c("llogis", "gamma", "lnorm"),
  computable = FALSE,
  silent = FALSE
)
```

Arguments

`data`	A data frame.
`left`	A string of the column in data with the concentrations.
`right`	A string of the column in data with the right concentration values.
`weight`	A string of the column in data with the weightings (or NULL)
`dists`	A character vector of the distribution names.
`computable`	A flag specifying whether to only return fits with numerically computable standard errors.
`silent`	A flag indicating whether fits should fail silently.

Details

By default the 'llogis', 'gamma' and 'lnorm' distributions are fitted to the data. The ssd_fit_dists function has also been tested with the 'gompertz', 'lgumbel' and 'weibull' distributions.

If weight specifies a column in the data frame with positive integers, weighted estimation occurs. However, currently only the resultant parameter estimates are available (via coef).

If the `right` argument is different to the `left` argument then the data are considered to be censored.

The fits are performed using `fitdistrplus::fitdist()` (and `fitdistrplus::fitdistcens()` in the case of censored data). The method used is "mle" (maximum likelihood estimation) which means that numerical optimization is carried out in `fitdistrplus::mledist()` using `stats::optim()` unless finite bounds are supplied in the (lower and upper) in which it is carried out using `stats::constrOptim()`. In both cases the "Nelder-Mead" method is used.

Value

An object of class fitdists (a list of `fitdistrplus::fitdist()` objects).

Examples

```
ssd_fit_dists(boron_data)
data(fluazinam, package = "fitdistrplus")
ssd_fit_dists(fluazinam, left = "left", right = "right")
```

---

ssd_gof *Goodness of Fit*

Description

Returns a tbl data frame with the following columns

dist The distribution name (chr)

aic Akaike's Information Criterion (dbl)

bic Bayesian Information Criterion (dbl)

and if the data are non-censored

aicc Akaike's Information Criterion corrected for sample size (dbl)

and if there are 8 or more samples

ad Anderson-Darling statistic (dbl)

ks Kolmogorov-Smirnov statistic (dbl)

cvm Cramer-von Mises statistic (dbl)

In the case of an object of class fitdists the function also returns

delta The Information Criterion differences (dbl)

weight The Information Criterion weights (dbl)

where `delta` and `weight` are based on `aic` for censored data and `aicc` for non-censored data.

Usage

```
ssd_gof(x, ...)

## S3 method for class 'fitdist'
ssd_gof(x, ...)

## S3 method for class 'fitdists'
ssd_gof(x, ...)

## S3 method for class 'fitdistcens'
```

```
ssd_gof(x, ...)

## S3 method for class 'fitdistscens'
ssd_gof(x, ...)
```

Arguments

x	The object.
...	Unused.

Value

A tbl data frame of the gof statistics.

Methods (by class)

- `fitdist`: Goodness of Fit
- `fitdists`: Goodness of Fit
- `fitdistcens`: Goodness of Fit
- `fitdistscens`: Goodness of Fit

Examples

```
ssd_gof(boron_lnorm)
ssd_gof(boron_dists)
ssd_gof(boron_lnorm)
ssd_gof(boron_dists)
ssd_gof(fluazinam_lnorm)
ssd_gof(fluazinam_lnorm)
```

---

ssd_hc *Hazard Concentration*

Description

Gets concentrations that protect specified percentages of species.

Usage

```
ssd_hc(x, ...)

## S3 method for class 'list'
ssd_hc(x, percent = 5, hc = 5, ...)

## S3 method for class 'fitdist'
ssd_hc(
  x,
```

```
  percent = 5,
  hc = 5,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  ...
)

## S3 method for class 'fitdistcens'
ssd_hc(
  x,
  percent = 5,
  hc = 5,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  ...
)

## S3 method for class 'fitdists'
ssd_hc(
  x,
  percent = 5,
  hc = 5,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  average = TRUE,
  ic = "aicc",
  ...
)

## S3 method for class 'fitdistscens'
ssd_hc(
  x,
  percent = 5,
  hc = 5,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
```

```
  average = TRUE,
  ic = "aic",
  ...
)
```

Arguments

x	The object.
...	Unused.
percent	A numeric vector of percentages.
hc	A numeric vector of percentages.
ci	A flag specifying whether to estimate confidence intervals (by parametric bootstrapping).
level	A number between 0 and 1 of the confidence level.
nboot	A count of the number of bootstrap samples to use to estimate the se and confidence limits.
parallel	A string specifying the type of parallel operation to be used ('no', 'snow' or 'multicore').
ncpus	A count of the number of parallel processes to use.
average	A flag specifying whether to model average the estimates.
ic	A string specifying which information-theoretic criterion ('aic', 'aicc' or 'bic') to use for model averaging .

Value

A data frame of the percent and concentrations.

Methods (by class)

- list: Hazard Percent list of distributions
- fitdist: Hazard Percent fitdist
- fitdistcens: Hazard Percent fitdistcens
- fitdists: Hazard Percent fitdists
- fitdistscens: Hazard Percent fitdistcens

Examples

```
ssd_hc(list("lnorm" = NULL))
ssd_hc(list("lnorm" = list(meanlog = 2, sdlog = 1)))
ssd_hc(boron_lnorm, c(0, 1, 30, Inf))
ssd_hc(fluazinam_lnorm, c(0, 1, 30, Inf))
ssd_hc(boron_dists, c(0, 1, 30, Inf))
ssd_hc(fluazinam_dists, c(0, 1, 30, Inf))
```

ssd_hp *Hazard Percent*

Description

Gets percent species protected at specified concentrations.

Usage

```
ssd_hp(x, ...)

## S3 method for class 'fitdist'
ssd_hp(
  x,
  conc,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  ...
)

## S3 method for class 'fitdistcens'
ssd_hp(
  x,
  conc,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  ...
)

## S3 method for class 'fitdists'
ssd_hp(
  x,
  conc,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  average = TRUE,
  ic = "aicc",
  ...
```

```
)

## S3 method for class 'fitdistscens'
ssd_hp(
  x,
  conc,
  ci = FALSE,
  level = 0.95,
  nboot = 1000,
  parallel = NULL,
  ncpus = 1,
  average = TRUE,
  ic = "aic",
  ...
)
```

Arguments

x	The object.
...	Unused.
conc	A numeric vector of concentrations.
ci	A flag specifying whether to estimate confidence intervals (by parametric bootstrapping).
level	A number between 0 and 1 of the confidence level.
nboot	A count of the number of bootstrap samples to use to estimate the se and confidence limits.
parallel	A string specifying the type of parallel operation to be used ('no', 'snow' or 'multicore').
ncpus	A count of the number of parallel processes to use.
average	A flag specifying whether to model average the estimates.
ic	A string specifying which information-theoretic criterion ('aic', 'aicc' or 'bic') to use for model averaging .

Value

A data frame of the conc and percent.

Methods (by class)

- `fitdist`: Hazard Percent fitdist
- `fitdistcens`: Hazard Percent fitdistcens
- `fitdists`: Hazard Percent fitdists
- `fitdistscens`: Hazard Percent fitdistcens

Examples

```
ssd_hp(boron_lnorm, c(0, 1, 30, Inf))
ssd_hp(fluazinam_lnorm, c(0, 1, 30, Inf))
ssd_hp(boron_dists, c(0, 1, 30, Inf))
ssd_hp(fluazinam_dists, c(0, 1, 30, Inf))
```

`ssd_match_moments` *Match Moments*

Description

Match Moments

Usage

```
ssd_match_moments(
  dists = c("llogis", "gamma", "lnorm"),
  meanlog = 1,
  sdlog = 1,
  nsim = 1e+05
)
```

Arguments

`dists`	A character vector of the distribution names.
`meanlog`	A number of the mean on the log scale.
`sdlog`	A number of the standard deviation on the log scale.
`nsim`	A positive whole number of the number of simulations to generate.

Value

A named list of the parameter values that produce a distribution with moments closest to the meanlog and sdlog.

See Also

`ssd_plot_cdf()`.

Examples

```
ssd_match_moments()
```

ssd_plot *SSD Plot*

Description

SSD Plot

Usage

```
ssd_plot(
  data,
  pred,
  left = "Conc",
  right = left,
  label = NULL,
  shape = NULL,
  color = NULL,
  size = 2.5,
  xlab = "Concentration",
  ylab = "Percent of Species Affected",
  ci = TRUE,
  ribbon = FALSE,
  hc = 5L,
  shift_x = 3
)
```

Arguments

data	A data frame.
pred	A data frame of the predictions.
left	A string of the column in data with the concentrations.
right	A string of the column in data with the right concentration values.
label	A string of the column in data with the labels.
shape	A string of the column in data for the shape aesthetic.
color	A string of the column in data for the color aesthetic.
size	A number for the size of the labels.
xlab	A string of the x-axis label.
ylab	A string of the x-axis label.
ci	A flag specifying whether to estimate confidence intervals (by parametric bootstrapping).
ribbon	A flag indicating whether to plot the confidence interval as a grey ribbon as opposed to green solid lines.
hc	A count between 1 and 99 indicating the percent hazard concentration (or NULL).
shift_x	The value to multiply the label x values by.

Examples

```
ssd_plot(boron_data, boron_pred, label = "Species", shape = "Group")
```

`ssd_plot_cdf` *Plot Cumulative Distribution Function*

Description

Plots the cdf.

Usage

```
ssd_plot_cdf(x, ...)

## S3 method for class 'list'
ssd_plot_cdf(x, xlab = "Concentration", ylab = "Species Affected", ...)

## S3 method for class 'fitdist'
ssd_plot_cdf(x, xlab = "Concentration", ylab = "Species Affected", ...)

## S3 method for class 'fitdistcens'
ssd_plot_cdf(x, xlab = "Concentration", ylab = "Species Affected", ...)

## S3 method for class 'fitdists'
ssd_plot_cdf(x, xlab = "Concentration", ylab = "Species Affected", ...)
```

Arguments

`x`	The object.
`...`	Unused.
`xlab`	A string of the x-axis label.
`ylab`	A string of the x-axis label.

Methods (by class)

- `list`: Plot list
- `fitdist`: Plot CDF fitdist
- `fitdistcens`: Plot CDF fitdistcens
- `fitdists`: Plot CDF fitdists

Examples

```
ssd_plot_cdf(boron_lnorm)
ssd_plot_cdf(boron_lnorm)
fluazinam_lnorm$censdata$right[3] <- fluazinam_lnorm$censdata$left[3] * 1.5
fluazinam_lnorm$censdata$left[5] <- NA
ssd_plot_cdf(fluazinam_lnorm)
ssd_plot_cdf(boron_dists)
```

ssd_plot_cf *Cullen and Frey Plot*

Description

Plots a Cullen and Frey graph of the skewness and kurtosis for non-censored data.

Usage

```
ssd_plot_cf(data, left = "Conc")

ssd_cfplot(data, left = "Conc")
```

Arguments

data	A data frame.
left	A string of the column in data with the concentrations.

Functions

- ssd_cfplot: Deprecated Cullen and Frey Plot

See Also

fitdistrplus::descdist()

Examples

```
ssd_plot_cf(boron_data)
```

stat_ssd *Plot Species Sensitivity Data*

Description

Uses the empirical cumulative density/distribution to visualize species sensitivity data.

Usage

```
stat_ssd(
  mapping = NULL,
  data = NULL,
  geom = "point",
  position = "identity",
  na.rm = FALSE,
  show.legend = NA,
  inherit.aes = TRUE,
  ...
)
```

Arguments

mapping	Set of aesthetic mappings created by aes() or aes_(). If specified and inherit.aes = TRUE (the default), it is combined with the default mapping at the top level of the plot. You must supply mapping if there is no plot mapping.
data	The data to be displayed in this layer. There are three options: If NULL, the default, the data is inherited from the plot data as specified in the call to ggplot(). A data.frame, or other object, will override the plot data. All objects will be fortified to produce a data frame. See fortify() for which variables will be created. A function will be called with a single argument, the plot data. The return value must be a data.frame, and will be used as the layer data. A function can be created from a formula (e.g. ~ head(.x,10)).
geom	The geometric object to use display the data
position	Position adjustment, either as a string, or the result of a call to a position adjustment function.
na.rm	If FALSE, the default, missing values are removed with a warning. If TRUE, missing values are silently removed.
show.legend	logical. Should this layer be included in the legends? NA, the default, includes if any aesthetics are mapped. FALSE never includes, and TRUE always includes. It can also be a named logical vector to finely select the aesthetics to display.
inherit.aes	If FALSE, overrides the default aesthetics, rather than combining with them. This is most useful for helper functions that define both data and aesthetics and shouldn't inherit behaviour from the default plot specification, e.g. borders().
...	Other arguments passed on to layer(). These are often aesthetics, used to set an aesthetic to a fixed value, like colour = "red" or size = 3. They may also be parameters to the paired geom/stat.

See Also

geom_ssd()

Examples

```
ggplot2::ggplot(boron_data, ggplot2::aes(x = Conc)) +
  stat_ssd()
```

`subset.fitdists` *Subset fitdists*

Description

Subset fitdists

Usage

```
## S3 method for class 'fitdists'
subset(x, select = names(x), ...)
```

Arguments

`x`	The object.
`select`	A character vector of the distributions to select.
`...`	Unused.

Examples

```
subset(boron_dists, c("gamma", "lnorm"))
```

`test_data` *Test Data*

Description

Data to test ssdtools.

Usage

```
test_data
```

Format

An object of class `tbl_df` (inherits from `tbl`, `data.frame`) with 141 rows and 2 columns.

Details

Chemical The chemical (chr).

Conc The chemical concentration (dbl).

Examples

```
head(test_data)
```

`weibull` *Weibull Distribution*

Description

Density, distribution function, quantile function and random generation for the weibull distribution with parameters shape and scale.

Usage

```
dweibull(x, shape = 1, scale = 1, log = FALSE)

pweibull(q, shape = 1, scale = 1, lower.tail = TRUE, log.p = FALSE)

qweibull(p, shape = 1, scale = 1, lower.tail = TRUE, log.p = FALSE)

rweibull(n, shape = 1, scale = 1)
```

Arguments

`x`	A numeric vector of values.
`shape`	A string of the column in data for the shape aesthetic.
`scale`	scale parameter.
`log`	logical; if TRUE, probabilities p are given as log(p).
`q`	vector of quantiles.
`lower.tail`	logical; if TRUE (default), probabilities are `P[X <= x]`,otherwise, `P[X > x]`.
`log.p`	logical; if TRUE, probabilities p are given as log(p).
`p`	vector of probabilities.
`n`	number of observations.

Value

A numeric vector.

See Also

`stats::dweibull()`

Examples

```
x <- seq(0.01, 5, by = 0.01)
plot(x, dweibull(x), type = "l")
```

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