

Package ‘smoothmest’

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Title Smoothed M-Estimators for 1-Dimensional Location

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Author Christian Hennig <christian.hennig@unibo.it>

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Description Some M-estimators for 1-dimensional location (Bisquare, ML for the Cauchy distribution, and the estimators from application of the smoothing principle introduced in Hampel, Hennig and Ronchetti (2011) to the above, the Huber M-estimator, and the median, main function is smoothm), and Pitman estimator.

Maintainer Christian Hennig <christian.hennig@unibo.it>

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URL <https://www.unibo.it/sitoweb/christian.hennig/en>

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Contents

ddoublex	2
dhuber	3
pdens	4
pitman	5
smoothm	6
smpsi	9
Index	11

`ddoublex`*The double exponential (Laplace) distribution*

Description

Density for and random values from double exponential (Laplace) distribution with density $\exp(-\text{abs}(x-\mu)/\lambda)/(2\lambda)$ for which the median is the ML estimator.

Usage

```
ddoublex(x, mu=0, lambda=1)
rdoublex(n, mu=0, lambda=1)
```

Arguments

<code>x</code>	numeric vector.
<code>mu</code>	numeric. Distribution median.
<code>lambda</code>	numeric. Scale parameter.
<code>n</code>	integer. Number of random values to be generated.

Details

ddoublex: density.

rdoublex: random number generation.

Value

`ddoublex` gives out a vector of density values.

`rdoublex` gives out a vector of random numbers generated by the double exponential distribution.

Author(s)

Christian Hennig <chrish@stats.ucl.ac.uk> <http://www.homepages.ucl.ac.uk/~ucakche/>

References

Huber, P. J. and Ronchetti, E. (2009) Robust Statistics (2nd ed.). Wiley, New York.

Examples

```
set.seed(123456)
ddoublex(1:5, lambda=5)
rdoublex(5, mu=10, lambda=5)
```

dhuber*Huber's least favourable distribution*

Description

Density for and random values from Huber's least favourable distribution, see Huber and Ronchetti (2009).

Usage

```
dhuber(x, k=0.862, mu=0, sigma=1)
edhuber(x, k=0.862, mu=0, sigma=1)
rhuber(n,k=0.862, mu=0, sigma=1)
```

Arguments

x	numeric vector.
k	numeric. Borderline value of central Gaussian part of the distribution. The default values refers to a 20% contamination neighborhood of the Gaussian distribution.
mu	numeric. distribution mean.
sigma	numeric. Distribution scale (sigma=1 defines the distribution in standard form, with standard Gaussian centre).
n	integer. Number of random values to be generated.

Details

dhuber: density.

edhuber: density, and computes the contamination proportion corresponding to k.

rhuber: random number generation.

Value

dhuber gives out a vector of density values.

edhuber gives out a list with components val (density values) and eps (contamination proportion).

rhuber gives out a vector of random numbers generated by Huber's least favourable distribution.

Author(s)

Christian Hennig <chrish@stats.ucl.ac.uk> <http://www.homepages.ucl.ac.uk/~ucakche/>

References

Huber, P. J. and Ronchetti, E. (2009) Robust Statistics (2nd ed.). Wiley, New York.

Examples

```
set.seed(123456)
edhuber(1:5,k=1.5)
rhuber(5)
```

pdens

Auxiliary functions for pitman

Description

Auxiliary functions for [pitman](#).

Usage

```
pdens(z, x, dfunction, ...)
sdens(z, x, dfunction, ...)
dens(x, dfunction, ...)
```

Arguments

<code>z</code>	numeric vector.
<code>x</code>	numeric vector.
<code>dfunction</code>	a density function defining the distribution for which the Pitman estimator is computed.
<code>...</code>	further arguments to be passed on to the density function <code>dfunction</code> .

Details

dens product of density values at `x`.

pdens vector of $z \cdot \text{dens}(x-z)$.

sdens vector of $\text{dens}(x-z)$.

Value

Numeric value (`dens`) or vector.

Author(s)

Christian Hennig <chrish@stats.ucl.ac.uk> <http://www.homepages.ucl.ac.uk/~ucakche/>

References

Pitman, E.J. (1939) The estimation of the location and scale parameters of a continuous population of any given form. *Biometrika* 30, 391-421.

See Also[pitman](#)**Examples**

```
dens(1:5,dcauchy)
pdens(1:5,0,dcauchy)
sdens(1:5,0:2,dcauchy)
```

pitman

Pitman location estimator

Description

Pitman estimator of one-dimensional location, optimal with scale assumed to be known. Calculated by brute force (using [integrate](#)).

Usage

```
pitman(y, d=ddoublex, lower=-Inf, upper=Inf, s=mad(y), ...)
```

Arguments

y	numeric vector. Data set.
d	a density function defining the distribution for which the Pitman estimator is computed.
lower	numeric. Lower bound for the involved integrals (should be $-\text{Inf}$ unless there are numerical problems).
upper	numeric. Lower bound for the involved integrals (should be Inf unless there are numerical problems).
s	numeric. Estimated or assumed scale/standard deviation.
...	further arguments to be passed on to the density function d.

Value

The estimated value.

Author(s)

Christian Hennig <chrish@stats.ucl.ac.uk> <http://www.homepages.ucl.ac.uk/~ucakche/>

References

Pitman, E.J. (1939) The estimation of the location and scale parameters of a continuous population of any given form. *Biometrika* 30, 391-421.

See Also[smoothm](#)**Examples**

```
set.seed(10001)
y <- rdoublex(7)
pitman(y, ddoublex)
pitman(y, dcauchy)
pitman(y, dnorm)
```

smoothm

*Smoothed and unsmoothed 1-d location M-estimators***Description**

smoothm is an interface for all the smoothed M-estimators introduced in Hampel, Hennig and Ronchetti (2011) for one-dimensional location, the Huber- and Bisquare-M-estimator and the ML-estimator of the Cauchy distribution, calling all the other functions documented on this page.

Usage

```
smoothm(y, method="smhuber",
        k=0.862, sn=sqrt(2.046/length(y)),
        tol=1e-06, s=mad(y), init="median")

sehuber(y, k = 0.862, tol = 1e-06, s=mad(y), init="median")

smhuber(y, k = 0.862, sn=sqrt(2.046/length(y)), tol = 1e-06, s=mad(y),
        smmed=FALSE, init="median")

mbisquare(y, k=4.685, tol = 1e-06, s=mad(y), init="median")

smbisquare(y, k=4.685, tol = 1e-06, sn=sqrt(1.0526/length(y)),
           s=mad(y), init="median")

mlcauchy(y, tol = 1e-06, s=mad(y))

smcauchy(y, tol = 1e-06, sn=sqrt(2/length(y)), s=mad(y))
```

Arguments

y	numeric vector. Data set.
method	one of "huber", "smhuber", "bisquare", "smbisquare", "cauchy", "smcauchy", "smmed". See details.

k	numeric. Tuning constant. This is used for method one of "huber", "smhuber", "bisquare", "smbisquare" in smoothm and the corresponding functions. Tuning constants are defined for the Huber- and Bisquare M-estimator as in Maronna et al. (2006). The default values refer to a Huber M-estimator which is optimal under 20% contamination (0.862) and to a Bisquare M-estimator with 95% efficiency under the Gaussian model (4.685).
sn	numeric. This is used for method one of "smhuber", "smbisquare", "smcauchy", "smmed". This is the smoothing standard error σ_n in Hampel et al. (2011) depending on the sample size and the asymptotic variance of the base estimator. The default value of smoothm and smhuber is based on a Huber estimator with $k=0.862$ under Huber's least favourable distribution for which it is ML. The default value of smbisquare is based on the Bisquare estimator with $k=4.685$ under the Gaussian distribution. The default value of smcauchy is based on the Cauchy ML estimator under the Cauchy distribution. A value that can be used for the smoothed median is $\sqrt{1.056/\text{length}(y)}$, which is based on the median under the double exponential (Laplace) distribution with $1.4826 \text{ MAD}=1$. Note that the distributional "assumptions" for these choices are by no means critical; they should work well under many other distributions as well.
tol	numeric. Stopping criterion for algorithms (absolute difference between two successive values).
s	numeric. Estimated or assumed scale/standard deviation.
init	"median" or "mean". Initial estimator for iteration. Ignored if method=="cauchy" or "smcauchy".
smmed	logical. If FALSE, the smoothed Huber estimator is computed, otherwise the smoothed median by smhuber.

Details

The following estimators can be computed (some computational details are given in Hampel et al. 2011):

Huber estimator. method="huber" and function sehuber compute the standard Huber estimator (Huber and Ronchetti 2009). The only differences from [huber](#) are that s and init can be specified and that the default k is different.

Smoothed Huber estimator. method="smhuber" and function smhuber compute the smoothed Huber estimator (Hampel et al. 2011).

Bisquare estimator. method="bisquare" and function bisquare compute the bisquare M-estimator (Maronna et al. 2006). This uses [psi.bisquare](#).

Smoothed bisquare estimator. method="smbisquare" and function smbisquare compute the smoothed bisquare M-estimator (Hampel et al. 2011). This uses [psi.bisquare](#)

ML estimator for Cauchy distribution. method="cauchy" and function mlcauchy compute the ML-estimator for the Cauchy distribution.

Smoothed ML estimator for Cauchy distribution. method="smcauchy" and function smcauchy compute the smoothed ML-estimator for the Cauchy distribution (Hampel et al. 2011).

Smoothed median. method="smmed" and function smhuber with median=TRUE compute the smoothed median (Hampel et al. 2011).

Value

A list with components

<code>mu</code>	the location estimator.
<code>method</code>	see above.
<code>k</code>	see above.
<code>sn</code>	see above.
<code>tol</code>	see above.
<code>s</code>	see above.

Author(s)

Christian Hennig <chrish@stats.ucl.ac.uk> <http://www.homepages.ucl.ac.uk/~ucakche/>

References

Hampel, F., Hennig, C. and Ronchetti, E. (2011) A smoothing principle for the Huber and other location M-estimators. *Computational Statistics and Data Analysis* 55, 324-337.

Huber, P. J. and Ronchetti, E. (2009) *Robust Statistics* (2nd ed.). Wiley, New York.

Maronna, A.R., Martin, D.R., Yohai, V.J. (2006). *Robust Statistics: Theory and Methods*. Wiley, New York

See Also

[pitman](#), [huber](#), [rlm](#)

Examples

```
library(MASS)
set.seed(10001)
y <- rdoublex(7)
median(y)
huber(y)$mu
smoothm(y)$mu
smoothm(y,method="huber")$mu
smoothm(y,method="bisquare",k=4.685)$mu
smoothm(y,method="smbisquare",k=4.685,sn=sqrt(1.0526/7))$mu
smoothm(y,method="cauchy")$mu
smoothm(y,method="smcauchy",sn=sqrt(2/7))$mu
smoothm(y,method="smmed",sn=sqrt(1.0526/7))$mu
smoothm(y,method="smmed",sn=sqrt(1.0526/7),init="mean")$mu
```

Description

Psi-functions, derivatives and further auxiliary functions used for computing the estimators in [smoothm](#).

Usage

```
psicauchy(x)
psidcauchy(x)
likcauchy(x,mu)
flikcauchy(y,x,mu,sn)
smtfcauchy(x,mu,sn)
smcipsi(y, x, sn=sqrt(2/length(x)))
smcipsid(y, x, sn=sqrt(2/length(x)))
smcpsi(x, sn=sqrt(2/length(x)))
smcpsid(x, sn=sqrt(2/length(x)))
smbpsi(y, x, k=4.685, sn=sqrt(2/length(x)))
smbpsid(y, x, k=4.685, sn=sqrt(2/length(x)))
smbpsii(x, k=4.685, sn=sqrt(2/length(x)))
smbpsidi(x, k=4.685, sn=sqrt(2/length(x)))
smpsi(x,k=0.862,sn=sqrt(2/length(x)))
smpmed(x,sn=sqrt(1/5))
```

Arguments

x	numeric vector.
mu	numeric.
y	numeric vector.
sn	numeric. Smoothing constant. See smoothm .
k	numeric. Tuning constant. See smoothm .

Details

psicauchy psi-function for Cauchy ML-estimator at x.

psidcauchy derivative of psicauchy at x.

likcauchy Cauchy likelihood of data x for mode parameter mu.

flikcauchy vector of Gaussian density at y with mean 0 and st. dev. sn times Cauchy log-likelihood of x with mode parameter mu+y.

smtfcauchy integral of flikcauchy with y running from -Inf to Inf.

smcipsi psicauchy(x-y)*dnorm(y,sd=sn).

smcpsid derivative of smcipsi w.r.t. x.

smcpsi psi-function for smoothed Cauchy ML-estimator. Integral of smpcipsi with y running from $-\infty$ to ∞ .

smcpsid integral of smpcipsid with y running from $-\infty$ to ∞ .

smbpsi $(x-y)*\text{psi.bisquare}(x-y,c=k)*\text{dnorm}(y, sd=sn)$.

smbpsid $\text{psi.bisquare}(x-y,c=k,\text{deriv}=1)*\text{dnorm}(y, sd=sn)$.

smbpsii psi-function for smoothed bisquare M-estimator. Integral of smbpsi with y running from $-\infty$ to ∞ .

smbpsidi integral of smbpsid with y running from $-\infty$ to ∞ .

smpsi psi-function for smoothed Huber-estimator at x.

smpmed psi-function for smoothed median at x.

Value

A numeric vector.

Author(s)

Christian Hennig <chrish@stats.ucl.ac.uk> <http://www.homepages.ucl.ac.uk/~ucakche/>

References

Hampel, F., Hennig, C. and Ronchetti, E. (2011) A smoothing principle for the Huber and other location M-estimators. Computational Statistics and Data Analysis 55, 324-337.

Huber, P. J. and Ronchetti, E. (2009) Robust Statistics (2nd ed.). Wiley, New York.

Maronna, A.R., Martin, D.R., Yohai, V.J. (2006). Robust Statistics: Theory and Methods. Wiley, New York

See Also

[smoothm](#), [psi.huber](#), [psi.bisquare](#)

Examples

```
psicauchy(1:5)
psidcauchy(1:5)
likcauchy(1:5,0)
flikcauchy(3,1:5,0,1)
smtfcauchy(1:5,0,1)
smcipsi(1,1:3)
smcpsid(1,1:3)
smcpsi(1:5)
smcpsid(1:5)
smbpsi(1,1:5)
smbpsid(0:4,1:5)
smbpsii(1:5)
smbpsidi(1:5)
smpsi(1:5)
smpmed(1:5)
```

Index

- * **distribution**
 - ddoublex, [2](#)
 - dhuber, [3](#)
- * **robust**
 - smoothm, [6](#)
 - smpsi, [9](#)
- * **univar**
 - pdens, [4](#)
 - pitman, [5](#)
 - smoothm, [6](#)
 - smpsi, [9](#)
- ddoublex, [2](#)
- dens (pdens), [4](#)
- dhuber, [3](#)
- edhuber (dhuber), [3](#)
- flikcauchy (smpsi), [9](#)
- huber, [7](#), [8](#)
- integrate, [5](#)
- likcauchy (smpsi), [9](#)
- mbisquare (smoothm), [6](#)
- mlcauchy (smoothm), [6](#)
- pdens, [4](#)
- pitman, [4](#), [5](#), [5](#), [8](#)
- psi.bisquare, [7](#), [10](#)
- psi.huber, [10](#)
- psicauchy (smpsi), [9](#)
- psidcauchy (smpsi), [9](#)
- rdoublex (ddoublex), [2](#)
- rhuber (dhuber), [3](#)
- rlm, [8](#)
- sdens (pdens), [4](#)
- sehuber (smoothm), [6](#)
- smbisquare (smoothm), [6](#)
- smbpsi (smpsi), [9](#)
- smbpsid (smpsi), [9](#)
- smbpsidi (smpsi), [9](#)
- smbpsii (smpsi), [9](#)
- smcauchy (smoothm), [6](#)
- smcipsi (smpsi), [9](#)
- smcipsid (smpsi), [9](#)
- smcpsi (smpsi), [9](#)
- smcpsid (smpsi), [9](#)
- smhuber (smoothm), [6](#)
- smoothm, [6](#), [6](#), [9](#), [10](#)
- smpmed (smpsi), [9](#)
- smpsi, [9](#)
- smtfcauchy (smpsi), [9](#)