Package ‘DELTD’

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Type Package

Title Kernel Density Estimation using Lifetime Distributions

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Description A collection of asymmetrical kernels belong to lifetime distributions for kernel density estimation is presented.
Mean Squared Errors (MSE) are calculated for estimated curves. For this purpose, R functions allow the distribution to be Gamma, Exponential or Weibull.
For de-
tails see Chen (2000), Jin and Kawczak (2003) and Salha et al. (2014) <doi:10.12988/pms.2014.4616>.

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R topics documented:

`DELTD-package` *DELTD*

Description

A collection of asymmetrical kernels belong to lifetime distributions for kernel density estimation is presented. i.e. `plot.BS`, `plot.Erlang`, `plot.Gamma`, `plot.LN` and for plotting all densities at same time `dencomb`. Estimated values can also observed by using `BS`, `Gamma`, `Erlang` and `LN`. For calculating mean squared error by using different kernels functions are `mseBS`, `mseEr`, `mseGamma` and `mseLN`.

Details

Kernel Density Estimation using Lifetime Distributions

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

- Jin, X.; Kawczak, J. 2003. Birnbaum-Saunders & Lognormal kernel estimators for modeling durations in high frequency financial data. *Annals of Economics and Finance* **4**, 103–124.
- Salha, R. B.; Ahmed, E. S.; Alhoubi, I. M. 2014. Hazard rate function estimation ksing Erlang Kernel. *Pure Mathematical Sciences* **3** (4), 141–152.
- Chen, S. X. 2000. Probability density function estimation using Gamma kernels. *Annals of the Institute of Statistical Mathematics* **52** (3), 471-480.

See Also

Useful links:

- `https://CRAN.R-project.org/package=DELTD`

BS *Estimated Density Values by Birnbaum-Saunders kernel*

Description

Estimated Values by using Birnbaum-Saunders Kernel.

Usage

```
BS(y, k, h)
```

Arguments

y	a numeric vector of positive values.
k	gird points
h	the bandwidth

Details

The Birnbaum-Saunders kernel is developed by Jin and Kawczak (2003). They claimed that performance of their developed kernel is better near the boundary points in terms of boundary reduction.

$$K_{BS(h^{\frac{1}{2}},x)}(y) = \frac{1}{2\sqrt{2\pi h}}\left(\sqrt{\frac{1}{xy}}+\sqrt{\frac{x}{y^3}}\right) exp\left(-\frac{1}{2h}\left(\frac{y}{x}-2+\frac{x}{y}\right)\right)$$

Value

x	grid points
y	estimated values of density

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Jin, X.; Kawczak, J. 2003. Birnbaum-Saunders & Lognormal kernel estimators for modeling durations in high frequency financial data. *Annals of Economics and Finance* **4**, 103–124.

See Also

For further kernels see Erlang, Gamma and LN. To plot the density by using BS kernel plot.BS and to calculate MSE by using Birnbaum-Saunders Kernel mseBS.

Examples

```
 y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
BS(y,200,h)
```

dencomb *Plot the Densities for Comparison*

Description

Plot the Estimated Densities with Real Density for Comparison .

Usage

```
dencomb(y, k, h, comb)
```

Arguments

y	a numeric vector of positive values.
k	gird points.
h	the bandwidth
comb	mention the combination which kernel estimated densities are to be compared. If Lognormal and Birnbaum-Saunders kernel densities are to be compared along with real density then use "TLB". If Lognormal and Erlang then use "TLE". If Lognormal and Gamma to be compared then use "TLG". For Birnbaum-Saunders and Erlang use "TBE". For Birnbaum-Saunders and Gamma then use "TBG". For Erlang and Gamma use "TEG". For Lognormal, Birnbaum-Saunders and Erlang use "TLBE". For Lognormal, Birnbaum-Saunders and Gamma use "TLBG". For Birnbaum-Saunders, Erlang and Gamma use "TBEG". To compare all densities in one graph use "TLBEG".

Value

Plot of Estimated Densities with Real Data Density.

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

- Jin, X.; Kawczak, J. 2003. Birnbaum-Saunders & Lognormal kernel estimators for modeling durations in high frequency financial data. *Annals of Economics and Finance* **4**, 103–124.
- Salha, R. B.; Ahmed, E. S.; Alhoubi, I. M. 2014. Hazard rate function estimation ksing Erlang Kernel. *Pure Mathematical Sciences* **3** (4), 141–152.
- Chen, S. X. 2000. Probability density function estimation using Gamma kernels. *Annals of the Institute of Statistical Mathematics* **52** (3), 471-480.

See Also

For indivisual densities of each kernels see `plot.Erlang`, `plot.BS`, `plot.LN`, and `plot.Gamma`

Examples

```
## Not run:
y <- rexp(10,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
dencomb(y,20,h,"TLB")
## End(Not run)
```

`Erlang` *Estimated Density Values by Erlang kernel*

Description

Estimated values for density by using Erlang Kernel.

Usage

```
Erlang(y, k, h)
```

Arguments

y	a numeric vector of positive values.
k	gird points.
h	the bandwidth

Details

Erlang kernel is developed by Salha et al. (2014). They developed this asymmetrical kernal with its hazard function and also proved its asymtotic normality.

$$K_{E(x,\frac{1}{h})}(y) = \frac{1}{\Gamma(1+\frac{1}{h})}\left[\frac{1}{x}(1+\frac{1}{h})\right]^{\frac{h+1}{h}} y^{\frac{1}{h}} exp\left(-\frac{y}{x}(1+\frac{1}{h})\right)$$

Value

x	grid points
y	estimated values of density

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Salha, R. B.; Ahmed, E. S.; Alhoubi, I. M. 2014. Hazard rate function estimation ksing Erlang Kernel. *Pure Mathematical Sciences* **3** (4), 141–152.

See Also

For further MSE by using other kernels see BS, Gamma and LN. For plotting these estimated values plot.Erlang and for calculating MSE by using Erlang Kernel mseEr.

Examples

```
y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
Erlang(y,200,h)
```

Gamma — *Estimated Density Values by Gamma kernel*

Description

Estimated Kernel density values by using Gamma Kernel.

Usage

```
Gamma(y, k, h)
```

Arguments

y	a numeric vector of positive values.
k	gird points.
h	the bandwidth

Details

The Gamma kernel is developed by Chen (2000). He was first to introduce asymetrical kernels to control boundary Bias. Gamma Kernel is

$$K_{Gam1(\frac{x}{h+1},h)}(y) = \frac{y^{\frac{x}{h}} exp(-\frac{y}{h})}{\Gamma\frac{x}{(h+1)} h^{\frac{x}{h+1}}}$$

Value

x	grid points
y	estimated values of density

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Chen, S. X. 2000. Probability density function estimation using Gamma kernels. *Annals of the Institute of Statistical Mathematics* **52** (3), 471-480.

See Also

For further kernels see Erlang, BS and LN. To plot its density see plot.Gamma and to calculate MSE by using Gamma Kernel mseGamma.

Examples

```
y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
Gamma(y,200,h)
```

LN *Estimated Density Values by Lognormal kernel*

Description

Estimated Values of Density estimation by using Lognormal Kernel.

Usage

```
LN(y, k, h)
```

Arguments

y	a numeric vector of positive values.
k	gird points.
h	the bandwidth

Details

The Lognomal kernel is also developed by Jin and Kawczak (2003). For this too, they claimed that performance of their developed kernel is better near the boundary points in terms of boundary reduction. Lognormal Kernel is

$$K_{LN(\ln(x),4\ln(1+h))} = \frac{1}{\sqrt{(8\pi\ln(1+h))y)}} exp\left[-\frac{(\ln(y)-\ln(x))^2}{(8\ln(1+h))}\right]$$

Value

x	grid points
y	estimated values of density

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Jin, X.; Kawczak, J. 2003. Birnbaum-Saunders & Lognormal kernel estimators for modeling durations in high frequency financial data. *Annals of Economics and Finance* **4**, 103–124.

See Also

For further kernels see `Erlang`, `Gamma` and `BS`. To plot its density see `plot.LN` and to calculate MSE by using Lognormal Kernel `mseLN`.

Examples

```
y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
LN(y,200,h)
```

---

mseBS — *Calculate Mean Squared Error(MSE) when Birnbaum-Saunders kernel is used*

Description

Calculate MSE by using Birnbaum-Saunders Kernel.

Usage

```
mseBS(y, k, h, type)
```

Arguments

`y`	a numeric vector of positive values.
`k`	gird points.
`h`	the bandwidth
`type`	mention distribution of vector.If exponential distribution then use `"Exp"`. if use gamma distribution then use `"Gamma"`.If Weibull distribution then use `"Weibull"`.

Value

MSE

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Jin, X.; Kawczak, J. 2003. Birnbaum-Saunders & Lognormal kernel estimators for modeling durations in high frequency financial data. *Annals of Economics and Finance* **4**, 103–124.

See Also

For further MSE by using other kernels see mseLN, mseEr and mseGamma. For density estimation by using Birnbaum-Saunders Kernel plot.BS and to examine estimated values with grid points see BS.

Examples

```
y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
mseBS(y,200,h,"Exp")
```

---

mseEr — *Calculate Mean Squared Error(MSE) when Erlang kernel is used*

Description

Calculate MSE by using Erlang Kernel.

Usage

```
mseEr(y, k, h, type)
```

Arguments

y	a numeric vector of positive values.
k	gird points.
h	the bandwidth
type	mention distribution of vector.If exponential distribution then use "Exp". if use gamma distribution then use "Gamma".If Weibull distribution then use "Weibull".

Value

MSE

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Salha, R. B.; Ahmed, E. S.; Alhoubi, I. M. 2014. Hazard rate function estimation ksing Erlang Kernel. *Pure Mathematical Sciences* **3** (4), 141–152.

See Also

For further MSE by using other kernels see mseBS, mseLN and mseGamma. For estimated values for density estimation Erlang and for density estimation by using Erlang Kernel plot.Erlang.

Examples

```
y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
mseEr(y,200,h,"Exp")
```

---

mseGamma *Calculate Mean Squared Error(MSE) when Gamma kernel is used*

Description

Calculate MSE by using Gamma Kernel.

Usage

```
mseGamma(y, k, h, type)
```

Arguments

y	a numeric vector of positive values.
k	gird points.
h	the bandwidth
type	mention distribution of vector.If exponential distribution then use "Exp". If use gamma distribution then use "Gamma".If Weibull distribution then use "Weibull".

Value

MSE

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Chen, S. X. 2000. Probability density function estimation using Gamma kernels. *Annals of the Institute of Statistical Mathematics* **52** (3), 471-480.

See Also

For further MSE by using other kernels see mseBS, mseEr and mseLN. For density estimation by using Gamma Kernel plot.Gamma and for estimated values of density Gamma.

Examples

```
y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
mseGamma(y,200,h,"Exp")
```

mseLN — *Calculate Mean Squared Error(MSE) when Lognormal Kernel is used*

Description

Calculate MSE by using Lognormal Kernel.

Usage

```
mseLN(y, k, h, type)
```

Arguments

y	a numeric vector of positive values.
k	gird points.
h	the bandwidth
type	mention distribution of vector.If exponential distribution then use "Exp". if use gamma distribution then use "Gamma".If Weibull distribution then use "Weibull".

Value

MSE

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Jin, X.; Kawczak, J. 2003. Birnbaum-Saunders & Lognormal kernel estimators for modeling durations in high frequency financial data. *Annals of Economics and Finance* **4**, 103–124.

See Also

For further MSE by using other kernels see mseBS, mseEr and mseGamma. For estimated values and for density estimation by using Lognormal Kernel see LN and plot.LN, respectively.

Examples

```
y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
mseLN(y,200,h,"Exp")
```

`plot.BS` *Density Plot by Birnbaum-Saunders kernel*

Description

Plot Kernel density by using Birnbaum-Saunders Kernel.

Usage

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

Arguments

`x`	An object of class "BS"
`...`	Not presently used in this implementation

Value

Nothing

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Jin, X.; Kawczak, J. 2003. Birnbaum-Saunders & Lognormal kernel estimators for modeling durations in high frequency financial data. *Annals of Economics and Finance* **4**, 103–124.

See Also

For further kernels see `plot.Erlang`, `plot.Gamma` and `plot.LN`. For estimated values `BS` and for MSE `mseBS`.

Examples

```
y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
den <- BS(y,200,h)
plot(den, type = "s", ylab = "Density Function", lty = 1, xlab = "Time")
## To add true density along with estimated
d1<-density(y,bw=h)
lines(d1,type="p",col="green")
```

plot.Erlang *Density Plot by Erlang kernel*

Description

Plot Kernel density by using Erlang Kernel.

Usage

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

Arguments

x	An object of class "Erlang"
...	Not presently used in this implementation

Value

Nothing

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Salha, R. B.; Ahmed, E. S.; Alhoubi, I. M. 2014. Hazard rate function estimation ksing Erlang Kernel. *Pure Mathematical Sciences* **3** (4), 141–152.

See Also

For further MSE by using other kernels see plot.BS, plot.Gamma and plot.LN. For estimated values Erlang and for calculating MSE by using Erlang Kernel mseEr.

Examples

```
y <- rexp(23,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
ans <- Erlang(y,90,h)
plot(ans, type = "s", ylab = "Density Function", lty = 1, xlab = "Time")
## To add true density along with estimated
d1<-density(y,bw=h)
lines(d1,type="p",col="red")
legend("topright", c("Real Density", "Density by Erlang Kernel"), col=c("red", "black"), lty=c(1,2))
```

plot.Gamma *Density Plot by Gamma kernel*

Description

Plot density by using Gamma Kernel.

Usage

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

Arguments

x	an object of class "BS"
...	Not presently used in this implementation

Value

nothing

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Chen, S. X. 2000. Probability density function estimation using Gamma kernels. *Annals of the Institute of Statistical Mathematics* **52** (3), 471-480.

See Also

For further kernels see plot.Erlang, plot.BS and plot.LN. To calculate its estimated values see Gamma and for MSE by using Gamma Kernel mseGamma.

Examples

```
y <- rexp(100,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
den <- Gamma(y,200,h)
plot(den, type = "s", ylab = "Density Function", lty = 1, xlab = "Time")
```

plot.LN *Density Plot by Lognormal kernel*

Description

Plot Kernel density by using Lognormal Kernel.

Usage

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

Arguments

x	An object of class "LN"
...	Not presently used in this implementation

Value

Nothing

Author(s)

Javaria Ahmad Khan, Atif Akbar.

References

Jin, X.; Kawczak, J. 2003. Birnbaum-Saunders & Lognormal kernel estimators for modeling durations in high frequency financial data. *Annals of Economics and Finance* **4**, 103–124.

See Also

For further kernels see plot.Erlang, plot.Gamma and plot.BS. To calculate MSE by using Lognormal Kernel mseLN and for estimated values for density estimation see LN.

Examples

```
y <- rexp(23,1)
h <- 0.79 * IQR(y) * length(y) ^ (-1/5)
den <- LN(y,90,h)
plot(den, type = "s", ylab = "Density Function", lty = 1, xlab = "Time")
## To add true density along with estimated
d1 <- density(y,bw=h)
lines(d1,type="p",col="red")
```

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