Package ‘eel’

September 1, 2015

Type Package

Title Extended Empirical Likelihood

Version 1.1

Date 2015-08-30

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Description Compute the extended empirical log likelihood ratio (Tsao & Wu, 2014) for the mean and parameters defined by estimating equations.

Depends emplik, rootSolve

License GPL (>= 2)

NeedsCompilation no

Repository CRAN

Date/Publication 2015-09-01 17:31:11

R topics documented:

`eel-package` *Extended Empirical Likelihood*

Description

Compute the extended empirical log likelihood ratio (Tsao & Wu, 2014) for the mean and parameters defined by estimating equations.

Details

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```

The extended empirical log likelihood ratio for the mean is computed by calling the function EEL(), and that for the parameter defined estimating equations is computed by calling the function EEL_est(). This package requires pre-installation of two packages "emplik" and "rootSolve". These are needed for computing the prime image of a point theta as well as the final extended empirical log likelihood ratio value as described in Tsao and Wu (2013, 2014). Only the first-order EEL discussed Tsao and Wu (2013, 2014) is included in this package.

Author(s)

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References

Tsao, M. (2013). Extending the empirical likelihood by domain expansion. The Canadian Journal of Statistics, 41 (2), 257-274.

Tsao, M., & Wu, F. (2013). Empirical likelihood on the full parameter space. Annals of Statistics, 0 (00), 1-21. doi: 10.1214/13-AOS1143

Tsao, M., & Wu, F. (2014). Extended empirical likelihood for estimating equations.Biometrika, 1-8. doi: 10.1093/biomet/asu014

See Also

`EMLogLR`, `EEL`, `EEL_est`, `exp_factor`, `prime_image`, `prime_image_est`, `exp_factor_est`,

Examples

```
# EXAMPLE: computing the EEL for the mean of a bivariate random variable
# Generating a sample of n=40 bivariate observations.
# For this example, we do this through a univariate normal random number generator.

uninorm<- rnorm(40*2,5,1)
multnorm<-matrix(uninorm,ncol=2)

# To calculate the EEL for a point theta=c(5,2), use
EEL(x=multnorm,theta=c(5,2))

# an example to use the EEL_est in the case of estimating equation

# generate regression dataset
# random variable x
dmx2<-runif(100,min=0,max=100)
dmx<-matrix(0,100,2)
dmx[,1]=1
dmx[,2]=dmx2

# set the initial beta value
beta0<-c(1,2)

# generate random errors and calculate the response variable
errdata<-rnorm(100,0,1)
ydata<-dmx%*%beta0+errdata

# calculate the maximum empirical likelihood estimates
beta_lse<-solve(t(dmx)%*%dmx)%*%(t(dmx)%*%ydata)

num=EEL_est(x=dmx,theta=c(1,2),theta_tilda=beta_lse,
"gx<-matrix(0,nrow=100,ncol=2)
for(i in 1:2){gx[,i]<-dmx[,i]*(ydata-dmx%*%as.matrix(theta))}
gx")
summary(num)
```

`EEL` *Extended empirical log likelihood ratio for the mean*

Description

Calculate the extended empirical log likelihood ratio for a multi-dimensional mean

Usage

```
EEL(x, theta)
## Default S3 method:
EEL(x,theta)
```

Arguments

`x`	Data matrix.
`theta`	The value at which the extended empirical likelihood is to be evaluated.

Value

An object of class `EEL`, basically a list including elements

`theta`	the value at which the extended empirical likelihood is to be evaluated;
`prime`	the prime-image inside the convex hull for the point theta;
`estimating equation`	the estimating equation here is "x-theta";
`expansion`	the value of the expansion factor gamma;
`oel_log`	the original empirical log likelihood ratio value;
`eel_log`	the extended empirical log likelihood ratio value.

Author(s)

Yu Zhang & Fan Wu

See Also

`EMLogLR`, `exp_factor`, `prime_image`, `print.EEL`, `summary.EEL`, `EEL_est`

Examples

```
# EXAMPLE: computing the EEL for the mean of a bivariate random variable
# Generating a sample of n=40 bivariate observations.
# For this example, we do this through a univariate normal random number generator.

uninorm<- rnorm(40*2,5,1)
multnorm<-matrix(uninorm,ncol=2)

# To calculate the EEL for a point theta=c(5,3), use
EEL(x=multnorm,theta=c(5,3))
```

EEL_est — *Extended empirical log likelihood ratio for parameters defined by estimating equaitons*

Description

Calculate the extended empirical log likelihood ratio for parameters defined by estimating equations

Usage

```
EEL_est(x, theta, theta_tilda, equation)
## Default S3 method:
EEL_est(x, theta, theta_tilda, equation)
```

Arguments

`x`	Data matrix.
`theta`	Value at which the EEL for the parameters defined by estimating equations will be evaluated.
`theta_tilda`	The maximum empirical likelihood estimator of the unknown parameter.
`equation`	The estimating equation, must be put inside quotation marks and has to be a function of theta.

Value

An object of class `EEL`, basically a list including elements

`theta`	value at which the EEL for the parameters defined by estimating equations will be evaluated;
`prime`	the prime-image inside the convex hull for the point theta;
`estimating equation`	the estimating equation;
`expansion`	the value of the expansion factor gamma;
`oel_log`	the original empirical log likelihood ratio value;
`eel_log`	the extended empirical log likelihood ratio value.

Author(s)

Yu Zhang

See Also

`EMLogLR`,`exp_factor_est`,`prime_image_est`,`print.EEL`,`summary.EEL`,`eel-package`, `EEL`

Examples

```
# EXAMPLE: computing the EEL for the mean of a bivariate random variable
# Generating a sample of n=40 bivariate observations.
# For this example, we do this through a univariate normal random number generator.

uninorm<- rnorm(40*2,5,1)
multnorm<-matrix(uninorm,ncol=2)

# To calculate the EEL for a point theta=c(5,3), use
theta_tilda=colMeans(multnorm-as.vector(c(5,3)))
EEL_est(x=multnorm,theta=c(5,3),theta_tilda, "x-theta")
```

EMLogLR *Original empirical log likelihood ratio*

Description

The function extracts the empirical log likelihood ratio value produced by el.test() function from package "emplik".

Usage

```
EMLogLR(x, mean)
```

Arguments

x	Data matrix.
mean	The mean value to be evaluated.

Value

The function will return a numerical value representing the original empirical log likelihood ratio.

Author(s)

Yu Zhang & Fan Wu

See Also

EEL

Examples

```
x=rnorm(50,0,1)
# find the empirical log likelihood ratio at point 0
EMLogLR(x,0)
```

`exp_factor` *Calculating expansion factor for EEL for the mean*

Description

The function calculates the first order expansion factor of EEL for the mean.

Usage

```
exp_factor(x, theta)
## Default S3 method:
exp_factor(x,theta)
```

Arguments

`x`	Data matrix of interest.
`theta`	The value to be evaluated.

Details

The first order expansion factor for calculating EEL is defined as

$$\gamma(n, l(\theta)) = 1 + \frac{l(\theta)}{2n}.$$

Value

The function will return a numerical value representing the value of the expansion factor calculated.

Author(s)

Fan Wu & Yu Zhang

References

Tsao, M. (2013). Extending the empirical likelihood by domain expansion. The Canadian Journal of Statistics, 41 (2), 257-274.

See Also

`EEL`, `prime_image`, `exp_factor_est`

Examples

```
x=rnorm(400,0,3)
exp_factor(x,0)
```

`exp_factor_est` *Calculating expansion factor for EEL for parameters defined by estimating equations*

Description

The function calculates the first order expansion factor of EEL for the parameters defined by estimating equations.

Usage

```
exp_factor_est(x, theta, equation)
## Default S3 method:
exp_factor_est(x,theta,equation)
```

Arguments

`x`	Data Matrix.
`theta`	The value to be evaluated.
`equation`	The estimating equation by which the parameters are defined.

Details

The first order expansion factor for calculating EEL is defined as

$$\gamma(n, l(\theta)) = 1 + \frac{l(\theta)}{2n}.$$

The estimating equation input has to be a function of theta.

Value

The function will return a numerical value representing the value of the expansion factor calculated.

Author(s)

Yu Zhang and Fan Wu

References

Tsao, M. (2013). Extending the empirical likelihood by domain expansion. The Canadian Journal of Statistics, 41 (2), 257-274.

See Also

`eel-package`, `exp_factor`, `EEL_est`, `prime_image_est`

Examples

```
#generate data with theoretical mean 2 and standard deviation 1
x=rnorm(100,2,1)
exp_factor_est(x=x, theta=2, equation="x-theta")
```

---

prime_image — *Calculating prime-image based on similarity mapping for the mean*

Description

The function calculates the prime image of the given point based on the similarity mapping defined in the EEL calculaiton.

Usage

```
prime_image(theta_tilda, theta, x)
## Default S3 method:
prime_image(theta_tilda,theta,x)
```

Arguments

theta_tilda	Sample mean or the maximum empirical likelihood estimate of the estimating equaitons.
theta	Value to be evaluated.
x	Data matrix.

Details

The prime image was found by solving the equation

$$f(\zeta'') = \zeta'.$$

See the reference paper for details.

Value

The function returns a vector, with the same length as the mean, representing the prime image of the point theta, based on the similarity mapping defind in EEL calculation.

Author(s)

Fan Wu and Yu Zhang

References

Tsao, M. (2013). Extending the empirical likelihood by domain expansion. The Canadian Journal of Statistics, 41 (2), 257-274.

Tsao, M., & Wu, F. (2013). Empirical likelihood on the full parameter space. Annals of Statistics, 0 (00), 1-21. doi: 10.1214/13-AOS1143

See Also

EEL,exp_factor,eel-package,prime_image_est

Examples

```
x=rnorm(50,6,2)
# find the prime image of true mean
prime_image(theta_tilda=mean(x),theta=6,x=x)
```

---

prime_image_est — *Calculating prime-image based on similarity mapping for parameters defined by estimating equations*

Description

The function calculates the prime image of a given point based on the similarity mapping defined in the EEL calculaiton.

Usage

```
prime_image_est(theta_tilda, theta, x, equation)
## Default S3 method:
prime_image_est(theta_tilda, theta, x, equation)
```

Arguments

theta_tilda	The maximum empirical likelihood estimates for parameters defined by estimating equations.
theta	The value to be evaluated.
x	Data Matrix.
equation	The estimating equation by which the parameters are defined, must be put as a function of theta.

Details

The prime image was found by solving the equation

$$f(\zeta'') = \zeta'.$$

See the reference paper for details.

Value

The function returns a vector, with the same dimension as the mean, representing the prime image of the point theta, based on the similarity mapping defind in EEL calculation.

Author(s)

Yu Zhang

References

Tsao, M. (2013). Extending the empirical likelihood by domain expansion. The Canadian Journal of Statistics, 41 (2), 257-274.

Tsao, M., & Wu, F. (2013). Empirical likelihood on the full parameter space. Annals of Statistics, 0 (00), 1-21. doi: 10.1214/13-AOS1143

See Also

EEL,exp_factor_est,EEL_est,prime_image

Examples

```
x=rnorm(50,6,2)
# find the prime image of true mean
prime_image_est(theta_tilda=mean(x),theta=6,x=x,"x-theta")
```

---

print.EEL *Printing EEL objects*

Description

The function prints the extended empirical log likelihood ratio.

Usage

```
## S3 method for class 'EEL'
print(x,...)
```

Arguments

x	EEL object.
...	Further arguments passed to or from other methods.

Value

The function prints the extended empirical log likelihood ratio value of the EEL object.

Author(s)

Yu Zhang

See Also

EEL

Examples

```
# EXAMPLE: computing the EEL for the mean of a bivariate random variable
# Generating a sample of n=40 bivariate observations.
# For this example, we do this through a univariate normal random number generator.

uninorm<- rnorm(40*2,5,1)
multnorm<-matrix(uninorm,ncol=2)

# To calculate the EEL for a point theta=c(5,3), use
obj=EEL(x=multnorm,theta=c(5,3))

print(obj)
```

---

summary.EEL *Summarizing EEL objects*

Description

The function prints a summary of EEL objects.

Usage

```
## S3 method for class 'EEL'
summary(object,...)
```

Arguments

`object`	An EEL object.
`...`	Additional arguments affecting the summary produced.

Value

The function prints a summary of EEL objects including

`theta`	the point at which the EEL is to be evaluated;
`estimating equation`	the estimating equation at which the paremeters are defined;
`log oel ratio`	empirical log likelihood ratio for the point theta;
`prime image`	prime-image of theta defined by the similarity mapping in EEL calculation;
`expansion factor`	value of the expansion factor $$\gamma(x,\theta)$$;
`log eel ratio`	value of the extended empirical log likelihood ratio.

Author(s)

Yu Zhang

See Also

EEL,print.EEL, EEL_est

Examples

```
# EXAMPLE: computing the EEL for the mean of a bivariate random variable
# Generating a sample of n=40 bivariate observations.
# For this example, we do this through a univariate normal random number generator.

uninorm<- rnorm(40*2,5,1)
multnorm<-matrix(uninorm,ncol=2)

# To calculate the EEL for a point theta=c(5,3), use
obj=EEL(x=multnorm,theta=c(5,3))

summary(obj)
```

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