Package: fabCI (via r-universe)

September 5, 2024

Title FAB Confidence Intervals

Version 0.2

Description Frequentist assisted by Bayes (FAB) confidence interval construction. See 'Adaptive multigroup confidence intervals with constant coverage' by Yu and Hoff <DOI:10.1093/biomet/asy009> and 'Exact adaptive confidence intervals for linear regression coefficients' by Hoff and Yu <DOI:10.1214/18-EJS1517>.

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Encoding UTF-8

LazyData true

Imports MASS

Date 2021-01-07

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RoxygenNote 5.0.1

Repository https://pdhoff.r-universe.dev

RemoteUrl https://github.com/pdhoff/fabci

RemoteRef HEAD

RemoteSha bd2004c9dc33b910ecdcf997df86e55ceaadaa10

Contents

`ebayes_est` *Empirical Bayes estimation of hyperparameters*

Description

Compute emprirical Bayes estimates of the error variance and distribution of the regression coefficients.

Usage

```
ebayes_est(y, X, emu = FALSE, dof = min(50, round(0.5 * (dim(X)[1] -
  dim(X)[2]))))
```

Arguments

`y`	a numeric vector of data
`X`	a design matrix
`emu`	(logical) estimate mean of coefficient (TRUE) or assume it is zero (FALSE)?
`dof`	degrees of freedom to use for the t-quantiles (the remainder go to adaptive estimation of the prior)

Details

This function computes the adaptive FAB confidence interval for each coefficient in a linear regression model.

Value

A list (s,sigma2,tau2,mu) where

1. s an estimate of the error standard deviation
2. sigma2 an estimate of the error variance, independent of s
3. tau2 an estimate of the coefficient variance, independent of s
4. mu an estimate of the coefficient mean, independent of s

Author(s)

Peter Hoff

fabregCI *FAB regression coefficient intervals*

Description

Compute the adaptive FAB t-intervals for the coefficients of a regression model.

Usage

```
fabregCI(y, X, alpha = 0.05, dof = min(50, round(0.5 * (dim(X)[1] -
  dim(X)[2]))), verbose = TRUE)
```

Arguments

y	a numeric vector of data
X	a design matrix
alpha	the type I error rate, so 1-alpha is the coverage rate
dof	degrees of freedom to use for the t-quantiles (the remainder go to adaptive estimation of the prior)
verbose	logical, print progress or not

Details

This function computes the adaptive FAB confidence interval for each coefficient in a linear regression model.

Value

A matrix where each row corresponds to the interval and OLS estimate of a coefficient.

Author(s)

Peter Hoff

fabtCI *FAB t-interval*

Description

Computation of a 1-alpha FAB t-interval

Usage

```
fabtCI(y, psi = c(0, 100, 1, 2), alpha = 0.05)
```

Arguments

y	a numeric vector with at least two non-missing values
psi	a length-four vector of hyperparameters for the prior
alpha	the type I error rate, so 1-alpha is the coverage rate

Details

A FAB interval is the "frequentist" interval procedure that is Bayes optimal: It minimizes the prior expected interval width among all interval procedures with exact 1-alpha frequentist coverage. This function computes the FAB t-interval for the mean of a normal population with an unknown variance, given a user-specified prior distribution determined by psi. The prior is that the population mean and variance are independently distributed as normal and inverse-gamma random variables. Referring to the elements of psi as mu, t2, s20, nu0, the prior is determined as follows:

1. mu is the prior expectation of the mean
2. t2 is the prior variance of the mean
3. the population variance is inverse-gamma(nu0/2,nu0 s20/2)

Author(s)

Peter Hoff

Examples

```
y<-rnorm(10)
fabtCI(y,c(0,10,1,5))
fabtCI(y,c(0,1/10,1,5))
fabtCI(y,c(2,10,1,5))
fabtCI(y,c(0,1/10,1,5))
```

---

fabtzCI *z-optimal FAB t-interval*

Description

Computation of a 1-alpha FAB t-interval using z-optimal spending function

Usage

```
fabtzCI(y, s, dof, alpha = 0.05, psi = list(mu = 0, tau2 = 1e+05, sigma2 =
  1))
```

Arguments

y	a numeric scalar, a normally distributed statistic
s	a numeric scalar, the standard error of y
dof	positive integer, degrees of freedom for s
alpha	the type I error rate, so 1-alpha is the coverage rate
psi	a list of parameters for the spending function, including 1. mu, the prior expectation of E[y] 2. tau2, the prior variance of E[y] 3. sigma2 the variance of y

Examples

```
n<-10
y<-rnorm(n)
fabtzCI(mean(y),sqrt(var(y)/n),n-1)
t.test(y)$conf.int
```

---

fabzCI *FAB z-interval*

Description

Computation of a 1-alpha FAB z-interval

Usage

```
fabzCI(y, mu, t2, s2, alpha = 0.05)
```

Arguments

y	a numeric scalar
mu	a numeric scalar
t2	a positive numeric scalar
s2	a positive numeric scalar
alpha	the type I error rate, so 1-alpha is the coverage rate

Details

A FAB interval is the "frequentist" interval procedure that is Bayes optimal: It minimizes the prior expected interval width among all interval procedures with exact 1-alpha frequentist coverage. This function computes the FAB z-interval for the mean of a normal population with an known variance, given a user-specified prior distribution determined by psi. The prior is that the population mean is normally distributed. Referring to the elements of psi as mu, t2, s2, the prior and population variance are determined as follows:

1. mu is the prior expectation of the mean
2. t2 is the prior variance of the mean
3. s2 is the population variance

Author(s)

Peter Hoff

Examples

```
y<-0
fabzCI(y,0,10,1)
fabzCI(y,0,1/10,1)
fabzCI(y,2,10,1)
fabzCI(y,0,1/10,1)
```

`hhetmodel` *Hierarchical heteroscedastic model estimates*

Description

Estimate across-group heterogeneity of means and variances

Usage

```
hhetmodel(y, g)
```

Arguments

y	a numeric vector of data
g	a group membership vector, of the same length as y

Details

This function estimates parameters in a hierarchical model for normally distributed groups, where the across-group model for means is normal and the across group model for variances is inverse-gamma.

Value

A vector (mu,t2,s20,nu0), where

1. mu is the mean of the group means
2. t2 is the variance of the group means
3. the the distribution of group variances is inverse-gamma(nu0/2,nu0 s20/2)

Author(s)

Peter Hoff

`hhommodel` *Hierarchical homoscedastic model estimates*

Description

Estimate across-group heterogeneity of means

Usage

```
hhommodel(y, g, group, p1)
```

Arguments

`y`	a numeric vector of data
`g`	a group membership vector, of the same length as y
`group`	the index of the group
`p1`	number of groups used to pool sample variance

Details

This function estimates parameters in a hierarchical model for normally distributed groups, where the across-group model for means is normal and the variance is the same across groups.

Value

A vector (s2,df,muw,t2w,s2w), where

1. s2 is the pooled variance
2. df is the degree of freedom of the t-quantiles
3. muw is the estimate mean of the group means
4. t2w is the estimate variance of the group means
5. s2w is the estimate within-group variance

Author(s)

Chaoyu Yu

multifabCI *Multigroup FAB t-intervals*

Description

Computation of 1-alpha FAB t-intervals for heteroscedastic multigroup data.

Usage

```
multifabCI(y, g, alpha = 0.05)
```

Arguments

y	a numeric vector of data
g	a group membership vector, of the same length as y
alpha	the type I error rate, so 1-alpha is the coverage rate

Details

For each group j, this function computes an estimate of the parameters in a hierarchical model for means and variances from data other than group j, and uses this information to construct a FAB t-interval for group j. These intervals have 1-alpha frequentist coverage, assuming within-group normality.

Author(s)

Peter Hoff

Examples

```
## -- simulated data
p<-10 ; n<-10
y<-rnorm(n*p) ; g<-rep(1:p,n)

## -- more interesting data takes longer
# data(radon) ; y<-radon[,2] ; g<-radon[,1]

## -- FAB t-intervals
FCI<-multifabCI(y,g)

## -- UMAU t-intervals
ybar<-tapply(y,g,mean) ; ssd<-tapply(y,g,sd) ; n<-table(g)
qtn<-cbind( qt(.025,n-1),  qt(.975,n-1) )
UCI<-sweep(sweep(qtn,1,ssd/sqrt(n),"*"),1,ybar,"+")

mean( (UCI[,2]-UCI[,1])/(FCI[,2]-FCI[,1]) , na.rm=TRUE)
```

multifabCIhom *Multigroup FAB t-intervals for the homoscedastic model*

Description

Computation of 1-alpha FAB t-intervals for homoscedastic multigroup data.

Usage

```
multifabCIhom(y, g, alpha = 0.05, prop = 0.5)
```

Arguments

y	a numeric vector of data
g	a group membership vector, of the same length as y
alpha	the type I error rate, so 1-alpha is the coverage rate
prop	the proportion of groups to obtain the sample variance estimate

Details

For each group j, this function computes an estimate of the parameters in a hierarchical model for means using data from other groups, and uses this information to construct a FAB t-interval for group j. These intervals have 1-alpha frequentist coverage, assuming within-group normality and that the within group variance is the same across groups.

Author(s)

Chaoyu Yu

Examples

```
## -- simulate the data
mu = 0; sigma2 = 10; tau2 = 1; p =100;
theta = rnorm(p,mu,sqrt(tau2))
ns = round(runif(p,2,18))
Y=c()
for(i in 1:p){
 d2 = rnorm(ns[i],theta[i],sqrt(sigma2))
 d1 = rep(i,ns[i])
 d = cbind(d1,d2)
 Y = rbind(Y,d)}
y = Y[,2]
g = Y[,1]

## -- FAB t-intervals
FCI = multifabCIhom(y,g)

## -- UMAU t-intervals
```

```
ybar<-tapply(y,g,mean) ; ssd<-tapply(y,g,sd) ; n<-table(g)
qtn<-cbind( qt(.025,n-1),  qt(.975,n-1) )
UCI<-sweep(sweep(qtn,1,ssd/sqrt(n),"*"),1,ybar,"+")

mean( (UCI[,2]-UCI[,1])/(FCI[,2]-FCI[,1]) , na.rm=TRUE)
```

---

radon *Minnesota Radon Dataset*

Description

Radon levels in 919 homes from 85 Minnesota counties

Usage

```
data(radon)
```

Format

A numeric matrix

Source

http://www.stat.columbia.edu/~gelman/arm/software/

---

sfabz *Bayes-optimal spending function*

Description

Compute Bayes optimal spending function

Usage

```
sfabz(theta, psi, alpha = 0.05)
```

Arguments

theta	value of theta being tested
psi	a list of parameters for the spending function, including 1. mu, the prior expectation of E[y] 2. tau2, the prior variance of E[y] 3. sigma2 the variance of y
alpha	level of test

Details

This function computes the value of s that minimizes the acceptance probability of a biased level-alpha test for a normal population with known variance, under a specified prior predictive distribution.

Author(s)

Peter Hoff

`umauregCI` *UMAU regression coefficient intervals*

Description

Compute the usual t-intervals for the coefficients of a regression model

Usage

```
umauregCI(y, X, alpha = 0.05)
```

Arguments

`y`	a numeric vector of data
`X`	a design matrix
`alpha`	the type I error rate, so 1-alpha is the coverage rate

Details

This function computes the 'usual' uniformly most accurate unbiased confidence interval for each coefficient in a linear regression model.

Value

A matrix where each row corresponds to the interval and OLS estimate of a coefficient.

Author(s)

Peter Hoff

Index