Package ‘fabCI’

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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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R topics documented:

`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

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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

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