Package ‘FABInference’

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Title FAB p-Values and Confidence Intervals

Version 0.1

Description Frequentist assisted by Bayes (FAB) p-values and confidence interval construction. See Hoff (2019) <arXiv:1907.12589> ``Smaller p-values via indirect information'', Hoff and Yu (2019) <doi:10.1214/18-EJS1517> ``Exact adaptive confidence intervals for linear regression coefficients'', and Yu and Hoff (2018) <doi:10.1093/biomet/asy009> ``Adaptive multigroup confidence intervals with constant coverage''.

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R topics documented:

`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

Value

a two-dimensional vector of the left and right endpoints of the interval

Author(s)

Peter Hoff

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

Value

a two-dimensional vector of the left and right endpoints of the interval

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)
```

glmFAB *FAB inference for generalized linear models*

Description

asymptotic FAB p-values and confidence intervals for parameters in generalized linear regression models

Usage

```
glmFAB(cformula, FABvars, lformula = NULL, alpha = 0.05,
  silent = FALSE, ...)
```

Arguments

cformula	formua for the control variables
FABvars	matrix of regressors for which to make FAB p-values and CIs
lformula	formula for the lining model (just specify right-hand side)
alpha	error rate for CIs (1-alpha CIs will be constructed)
silent	show progress (TRUE) or not (FALSE)
...	additional arguments to be passed to `glm`

Value

an object of the class `glmFAB` which inherits from `glm`

Author(s)

Peter Hoff

Examples

```
# n observations, p FAB variables, q=2 control variables

n<-100 ; p<-25

# X is design matrix for params of interest
# beta is vector of true parameter values
# v a variable in the linking model - used to share info across betas

v<-rnorm(p) ; beta<-(2 - 2*v + rnorm(p))/3 ; X<-matrix(rnorm(n*p),n,p)/8

# control coefficients and variables
alpha1<-.5 ; alpha2<- -.5
w1<-rnorm(n)/8
w2<-rnorm(n)/8
```

```
# simulate data
lp<-1 + alpha1*w1 + alpha2*w2 + X%*%beta
y<-rpois(n,exp(lp))

# fit model
fit<-glmFAB(y~w1+w2,X,~v,family=poisson)

fit$FABpv
fit$FABci
summary(fit) # look at p-value column
```

`lmFAB` *FAB inference for linear models*

Description

FAB p-values and confidence intervals for parameters in linear regression models

Usage

```
lmFAB(cformula, FABvars, lformula = NULL, alpha = 0.05,
  rssSplit = TRUE, silent = FALSE)
```

Arguments

`cformula`	formua for the control variables
`FABvars`	matrix of regressors for which to make FAB p-values and CIs
`lformula`	formula for the linking model (just specify right-hand side)
`alpha`	error rate for CIs (1-alpha CIs will be constructed)
`rssSplit`	use some residual degrees of freedom to help fit linking model (TRUE/FALSE)
`silent`	show progress (TRUE) or not (FALSE)

Value

an object of the class `lmFAB` which inherits from `lm`

Author(s)

Peter Hoff

Examples

```
# n observations, p FAB variables, q=2 control variables

n<-100 ; p<-25

# X is design matrix for params of interest
# beta is vector of true parameter values
# v a variable in the linking model - used to share info across betas

v<-rnorm(p) ; beta<-(2 - 2*v + rnorm(p))/3 ; X<-matrix(rnorm(n*p),n,p)/8

# control coefficients and variables
alpha1<-.5 ; alpha2<- -.5
w1<-rnorm(n)/8
w2<-rnorm(n)/8

# simulate data
lp<-1 + alpha1*w1 + alpha2*w2 + X%*%beta
y<-rnorm(n,lp)

# fit model
fit<-lmFAB(y~w1+w2,X,~v)

fit$FABpv
fit$FABci
summary(fit) # look at p-value column
```

---

mmleFH *Marginal MLEs for the Fay-Herriot model*

Description

Marginal MLEs for the Fay-Herriot random effects model where the covariance matrix for the sampling model is known to scale.

Usage

```
mmleFH(y, X, V, ss0 = 0, df0 = 0)
```

Arguments

y	direct data following normal model $y \sim N(\theta, V\sigma^2)$
X	linking model predictors $\theta \sim N(X\beta, \tau^2 I)$
V	covariance matrix to scale
ss0	prior sum of squares for estimate of σ^2
df0	prior degrees of freedom for estimate of σ^2

Value

a list of parameter estimates including

1. beta, the estimated regression coefficients
2. t2, the estimate of τ^2
3. s2, the estimate of σ^2

Author(s)

Peter Hoff

Examples

```
n<-30 ; p<-3
X<-matrix(rnorm(n*p),n,p)
beta<-rnorm(p)
theta<-X%*%beta + rnorm(n)
V<-diag(n)
y<-theta+rnorm(n)
mmleFH(y,X,V)
```

---

mmleFHP *Marginal MLEs for the Fay-Herriot model with known covariance*

Description

Marginal MLEs for the Fay-Herriot random effects model where the covariance matrix for the sampling model is known

Usage

```
mmleFHP(y, X, Sigma)
```

Arguments

y	direct data following normal model $y \sim N(\theta, \Sigma)$
X	linking model predictors $\theta \sim N(X\beta, \tau^2 I)$
Sigma	covariance matrix in sampling model

Value

a list of parameter estimates including

1. beta, the estimated regression coefficients
2. t2, the estimate of τ^2

Author(s)

Peter Hoff

Examples

```
n<-30 ; p<-3
X<-matrix(rnorm(n*p),n,p)
beta<-rnorm(p)
theta<-X%*%beta + rnorm(n)
Sigma<-diag(n)
y<-theta+rnorm(n)
mmleFHP(y,X,Sigma)
```

---

qr.lmFAB — *QR decomposition*

Description

QR decomposition for lmFAB objects

Usage

```
## S3 method for class 'lmFAB'
qr(x, ...)
```

Arguments

x	`lmFAB` object
...	see `qr.lm`, if you can find it

Value

qr decomposition for a design matrix

---

rssSplit — *Residual sum of squares split*

Description

Split residual sum of squares from normal linear regression

Usage

```
rssSplit(fit, df0 = max(1, floor(fit$df/10)), seed = -71407)
```

Arguments

`fit`	lm object
`df0`	degrees of freedom for the smaller of the two residual sums of squares
`seed`	random seed for constructing the basis vectors of the split

Value

a two-dimensional vector of independent sums of squares

Author(s)

Peter Hoff

Examples

```
n<-30 ; p<-6 ; sigma2<-1.5
X<-matrix(rnorm(n*p),n,p)
y<-X%*%rnorm(6) + sqrt(sigma2)*rnorm(n)
ss<-rssSplit(lm(y~ -1+X))
df<-as.numeric( substring(names(ss),first=3))
ss/df
```

`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.

Value

a scalar value giving the optimal tail-area probability

Author(s)

Peter Hoff

Examples

```
thetas<-seq(-1,1,length=100)
s<-NULL
for(theta in thetas){ s<-c(s,sfabz(theta,list(mu=0,tau2=1,sigma2=1)) ) }
plot(thetas,s,type="l")
```

---

summary.glmFAB *Summarizing Generalized Linear Model Fits with FAB Inference*

Description

`summary` method for class `glmFAB`

Usage

```
## S3 method for class 'glmFAB'
summary(object, dispersion = NULL,
  correlation = FALSE, symbolic.cor = FALSE, ...)
```

Arguments

`object`	an object of class `glmFAB`
`dispersion`	see `summary.glm`
`correlation`	see `summary.glm`
`symbolic.cor`	see `summary.glm`
`...`	see `summary.glm`

Details

A mod of `summary.glm` that shows FAB p-values in table

Value

A list of summary statistics of the fitted generalized linear model

Examples

```
# n observations, p FAB variables, q=2 control variables

n<-100 ; p<-25

# X is design matrix for params of interest
# beta is vector of true parameter values
# v a variable in the linking model - used to share info across betas

v<-rnorm(p) ; beta<-(2 - 2*v + rnorm(p))/3 ; X<-matrix(rnorm(n*p),n,p)/8

# control coefficients and variables
alpha1<-.5 ; alpha2<- -.5
w1<-rnorm(n)/8
w2<-rnorm(n)/8

# simulate data
lp<-1 + alpha1*w1 + alpha2*w2 + X%*%beta
y<-rpois(n,exp(lp))

# fit model
fit<-glmFAB(y~w1+w2,X,~v,family=poisson)

fit$FABpv
fit$FABci
summary(fit) # look at p-value column
```

`summary.lmFAB` *Summarizing Linear Model Fits with FAB Inference*

Description

`summary` method for class `lmFAB`

Usage

```
## S3 method for class 'lmFAB'
summary(object, correlation = FALSE,
  symbolic.cor = FALSE, ...)
```

Arguments

`object`	an object of class `lmFAB`
`correlation`	see `summary.lm`
`symbolic.cor`	see `summary.lm`
`...`	see `summary.lm`

Details

A mod of `summary.lm` that shows FAB p-values in table

Value

A list of summary statistics of the fitted linear model

Examples

```
# n observations, p FAB variables, q=2 control variables

n<-100 ; p<-25

# X is design matrix for params of interest
# beta is vector of true parameter values
# v a variable in the linking model - used to share info across betas

v<-rnorm(p) ; beta<-(2 - 2*v + rnorm(p))/3 ; X<-matrix(rnorm(n*p),n,p)/8

# control coefficients and variables
alpha1<-.5 ; alpha2<- -.5
w1<-rnorm(n)/8
w2<-rnorm(n)/8

# simulate data
lp<-1 + alpha1*w1 + alpha2*w2 + X%*%beta
y<-rnorm(n,lp)

# fit model
fit<-lmFAB(y~w1+w2,X,~v)

fit$FABpv
fit$FABci
summary(fit) # look at p-value column
```

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