Package 'ei'

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Title Ecological Inference

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Imports mvtnorm, msm, tmvtnorm, ellipse, plotrix, MASS, ucminf, cubature, mnormt, foreach, sp

Suggests rgl

Description Software accompanying Gary King's book: A Solution to the Ecological Inference Problem. (1997). Princeton University Press. ISBN 978-0691012407.

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R topics documented:

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bounds1 *Computes Analytical Bounds from Accounting Identity*

Description

Returns analytical bounds from accounting identity on unknown table relationships beta_b, beta_w, from known, observed, table marginals, x, t (and sample size n).

Usage

```
bounds1(x, t, n)
```

Arguments

x	vector of characteristics, e.g. percentage of blacks in each district
t	vector of characteristics, e.g. percentage of people that voted in each district
n	size of each observation, e.g. number of voters in each district

Author(s)

Gary King «email: king@harvard.edu» and Molly Roberts «email: molly.e.roberts@gmail.com»

References

Gary King (1997). A Solution to the Ecological Inference Problem. Princeton: Princeton University Press.

Examples

```
data(census1910)
output<-bounds1(x=census1910$x, t=census1910$t, n=census1910$n)
```

census1910 *Black Literacy in 1910*

Description

A dataset of aggregate literacy rates (t) and fraction of the population that is black (x), from the 1910 US Census. Each observation represents one county.

Usage

```
census1910
```

Format

A data frame containing 1030 observations.

Source

Gary King, 1997, "Replication data for: A Solution to the Ecological Inference Problem: Reconstructing Individual Behavior from Aggregate Data", http://hdl.handle.net/1902.1/LWMMKUTYXS UNF:3:DRWozWd89+vNLO7lY2AHbg== IQSS Dataverse Network [Distributor] V3 [Version]

References

Gary King. (1997). *A Solution to the Ecological Inference Problem.* Princeton: Princeton University Press. Section 13.2:241-5.

Robinson, William S. (1950). "Ecological Correlation and the Behavior of Individuals." *American Sociological Review* 15:351-357.

ei *Ecological Inference Estimation*

Description

`ei` is the main command in the package `EI`. It gives observation-level estimates (and various related statistics) of β_i^b and β_i^w given variables T_i and X_i ($i = 1, ..., n$) in this accounting identity: $T_i = \beta_i^b * X_i + \beta_i^w * (1 - X_i)$. Results are stored in an `ei` object, that can be read with `summary()` or `eiread()` and graphed in `plot()`.

Usage

```
ei(formula, total = NULL, Zb = 1, Zw = 1, id = NA, data =NA, erho = 0.5,
esigma = 0.5, ebeta = 0.5, ealphab = NA, ealphaw = NA, truth = NA,
simulate = TRUE, covariate = NULL, lambda1 = 4, lambda2 = 2,
covariate.prior.list = NULL, tune.list = NULL, start.list = NULL,
sample = 1000, thin = 1, burnin = 1000, verbose = 0, ret.beta = "r",
ret.mcmc = TRUE, usrfun = NULL)
```

Arguments

formula	A formula of the form $t\ x$ in the $2x2$ case and $cbind(col1, col2, ...)\ cbind(row1, row2, ...)$ in the RxC case.
total	'total' is the name of the variable in the dataset that contains the number of individuals in each unit
Zb	p x k^b matrix of covariates or the name of covariates in the dataset
Zw	p x k^w matrix of covariates or the name of covariates in the dataset
id	'id' is the nae of the variable in the dataset that identifies the precinct. Used for 'movie' and 'movieD' plot functions.
data	data frame that contains the variables that correspond to formula. If using covariates and data is specified, data should also contain Zb and Zw.
erho	The standard deviation of the normal prior on ϕ_5 for the correlation. Default $= 0.5$.
esigma	The standard deviation of an underlying normal distribution, from which a half normal is constructed as a prior for both $\breve{\sigma}_b$ and $\breve{\sigma}_w$. Default $= 0.5$
ebeta	Standard deviation of the "flat normal" prior on $\breve{B}^b$ and $\breve{B}^w$. The flat normal prior is uniform within the unit square and dropping outside the square according to the normal distribution. Set to zero for no prior. Setting to positive values probabilistically keeps the estimated mode within the unit square. Default$= 0.5$
ealphab	cols(Zb) x 2 matrix of means (in the first column) and standard deviations (in the second) of an independent normal prior distribution on elements of α^b. If you specify Zb, you should probably specify a prior, at least with mean zero and some variance (default is no prior). (See Equation 9.2, page 170, to interpret α^b).
ealphaw	cols(Zw) x 2 matrix of means (in the first column) and standard deviations (in the second) of an independent normal prior distribution on elements of α^w. If you specify Zw, you should probably specify a prior, at least with mean zero and some variance (default is no prior). (See Equation 9.2, page 170, to interpret α^w).
truth	A length(t) x 2 matrix of the true values of the quantities of interest.
simulate	default = TRUE:see documentation in eiPack for options for RxC ei.
covariate	see documentation in eiPack for options for RxC ei.
lambda1	default = 4:see documentation in eiPack for options for RxC ei.
lambda2	default = 2:see documentation in eiPack for options for RxC ei.
covariate.prior.list	see documentation in eiPack for options for RxC ei.
tune.list	see documentation in eiPack for options for RxC ei.
start.list	see documentation in eiPack for options for RxC ei.
sample	default = 1000
thin	default = 1
burnin	default = 1000

verbose	default = 0:see documentation in eiPack for options for RxC ei.
ret.beta	default = "r": see documentation in eiPack for options for RxC ei.
ret.mcmc	default = TRUE: see documentation in eiPack for options for RxC ei.
usrfun	see documentation in eiPack for options for RxC ei.

Details

The EI algorithm is run using the ei command. A summary of the results can be seen graphically using plot(ei.object) or numerically using summary(ei.object). Quantities of interest can be calculated using eiread(ei.object).

Author(s)

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References

Gary King (1997). A Solution to the Ecological Inference Problem. Princeton: Princeton University Press.

Examples

```
data(sample)
form <- t ~ x
dbuf <- ei(form,total="n",data=sample)
summary(dbuf)
```

---

ei.sim *Simulate EI Solution via Importance Sampling*

Description

Simulate EI solution via importance sampling

Usage

```
ei.sim(ei.object)
```

Arguments

ei.object	ei object

Author(s)

Gary King «email: king@harvard.edu» and Molly Roberts «email: molly.e.roberts@gmail.com»

References

Gary King (1997). A Solution to the Ecological Inference Problem. Princeton: Princeton University Press.

eiread *Quantities of Interest from Ecological Inference Estimation*

Description

eiread is the command that pulls quantities of interest from the ei object. The command returns a list of quantities of interest requested by the user.

Usage

```
eiread(ei.object, ...)
```

Arguments

ei.object	An ei object from the function ei.
...	A list of quantities of interest for eiread() to return. See values below.

Value

betab	p x 1 point estimate of β_i^b based on its mean posterior. See section 8.2
betaw	p x 1 point estimate of β_i^w based on its mean posterior. See section 8.2
sbetab	p x 1 standard error for the estimate of β_i^b, based on the standard deviation of its posterior. See section 8.2
sbetaw	p x 1 standard error for the estimate of β_i^w, based on the standard deviation of its posterior. See section 8.2
phi	Maximum posterior estimates of the CML
psisims	Matrix of random simulations of ψ. See section 8.2
bounds	p x 4: bounds on β_i^b and β_i^w, lowerB ~ upperB ~ lowerW ~ upperW. See Chapter 5.
abounds	2 x 2: aggregate bounds rows:lower, upper; columns: betab, betaw. See Chapter 5.
aggs	Simulations of district-level quantities of interest $\hat{B^b}$ and $\hat{B^w}$. See Section 8.3.
maggs	Point estimate of 2 district-level parameters, $\hat{B^b}$ and $\hat{B^w}$ based on the mean of aggs. See Section 8.3.
VCaggs	Variance matrix of 2 district-level parameters, $\hat{B^b}$ and $\hat{B^w}$. See Section 8.3.
CI80b	p x 2: lower~upper 80% confidence intervals for β_i^b. See section 8.2.
CI80w	p x 2: lower~upper 80% confidence intervals for β_i^w. See section 8.2.
eaggbias	Regressions of estimated β_i^b and β_i^w on a constant term and X_i.
goodman	Goodman's Regression. See Section 3.1

Author(s)

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References

Gary King (1997). A Solution to the Ecological Inference Problem. Princeton: Princeton University Press.

Examples

```
data(sample)
formula = t ~ x
dbuf <- ei(formula=formula, total="n",data=sample)
eiread(dbuf, "phi")
eiread(dbuf, "betab", "betaw")
```

---

eiRxCsample *A Sample Dataset*

Description

A description for this dataset

Usage

```
eiRxCsample
```

Format

A data frame containing 93 observations.

Source

Source

References

Gary King (1997). *A Solution to the Ecological Inference Problem.* Princeton: Princeton University Press.

fultongen *Voter Transitions*

Description

Aggregated data from 289 precincts in Fulton County, Georgia. The variable t represents the fraction voting in 1994 and x the fraction in 1992. Beta_b is then the fraction who vote in both elections, and Beta_w the fraction of nonvoters in 1992 who vote in the midterm election of 1994.

Usage

```
fultongen
```

Format

A data frame containing 289 observations.

Source

Gary King, 1997, "Replication data for: A Solution to the Ecological Inference Problem: Reconstructing Individual Behavior from Aggregate Data", http://hdl.handle.net/1902.1/LWMMKUTYXS UNF:3:DRWozWd89+vNLO7lY2AHbg== IQSS Dataverse Network [Distributor] V3 [Version]

References

Gary King (1997). *A Solution to the Ecological Inference Problem.* Princeton: Princeton University Press. Section 13.1:235-41.

lavoteall *Turnout by Race in Louisiana*

Description

The fraction of blacks registered voters (x) and fraction of voter turnout (t) in each Louisiana precinct, along with the true fraction of black turnout (tb) and non-black turnout (tw).

Usage

```
lavoteall
```

Format

A data frame containing 3262 observations.

Source

Gary King, 1997, "Replication data for: A Solution to the Ecological Inference Problem: Reconstructing Individual Behavior from Aggregate Data", http://hdl.handle.net/1902.1/LWMMKUTYXS UNF:3:DRWozWd89+vNLO7lY2AHbg== IQSS Dataverse Network [Distributor] V3 [Version]

References

Gary King (1997). *A Solution to the Ecological Inference Problem.* Princeton: Princeton University Press. Section 1.4:22-4.

`matproii` *Voter Registration by Race in Southern States*

Description

Aggregate voter registration and fraction black, in counties in Florida, Louisiana, North Carolina and South Carolina

Usage

```
matproii
```

Format

A data frame containing 268 observations.

Source

Gary King, 1997, "Replication data for: A Solution to the Ecological Inference Problem: Reconstructing Individual Behavior from Aggregate Data", http://hdl.handle.net/1902.1/LWMMKUTYXS UNF:3:DRWozWd89+vNLO7lY2AHbg== IQSS Dataverse Network [Distributor] V3 [Version]

References

Gary King (1997). *A Solution to the Ecological Inference Problem.* Princeton: Princeton University Press. Chapter 10.

nj *Nonminority Turnout in New Jersey*

Description

A description for this dataset

Usage

```
nj
```

Format

A data frame containing 493 observations.

Source

Gary King, 1997, "Replication data for: A Solution to the Ecological Inference Problem: Reconstructing Individual Behavior from Aggregate Data", http://hdl.handle.net/1902.1/LWMMKUTYXS UNF:3:DRWozWd89+vNLO7lY2AHbg== IQSS Dataverse Network [Distributor] V3 [Version]

References

Gary King (1997). *A Solution to the Ecological Inference Problem.* Princeton: Princeton University Press. Section 1.4:24-5.

plot.ei *Plotting Ecological Inference Estimates*

Description

'plot' method for the class 'ei'.

Usage

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

Arguments

x	An ei object from the function ei.
...	A list of options to return in graphs. See values below.

Details

Returns any of a set of possible graphical objects, mirroring those in the examples in King (1997). Graphical option `lci` is a logical value specifying the use of the Law of Conservation of Ink, where the implicit information in the data is represented through color gradients, i.e. the color of the line is a function of the length of the tomography line. This can be passed as an argument and is used for "tomogD" and "tomog" plots.

Value

`tomogD`	Tomography plot with the data only. See Figure 5.1, page 81.
`tomog`	Tomography plot with ML contours. See Figure 10.2, page 204.
`tomogCI`	Tomography plot with 80% confidence intervals. Confidence intervals appear on the screen in red with the remainder of the tomography line in yellow. The confidence interval portion is also printed thicker than the rest of the line. See Figure 9.5, page 179.
`tomogCI95`	Tomography plot with 95% confidence intervals. Confidence intervals appear on the screen in red with the remainder of the tomography line in yellow. The confidence interval portion is also printed thicker than the rest of the line. See Figure 9.5, page 179.
`tomogE`	Tomography plot with estimated mean posterior β_i^b and β_i^w points.
`tomogP`	Tomography plot with mean posterior contours.
`betab`	Density estimate (i.e., a smooth version of a histogram) of point estimates of β_i^b's with whiskers.
`betaw`	Density estimate (i.e., a smooth version of a histogram) of point estimates of β_i^w's with whiskers.
`xt`	Basic X_i by T_i scatterplot.
`xtc`	Basic X_i by T_i scatterplot with circles sized proportional to N_i.
`xtfit`	X_i by T_i plot with estimated $E(T_i\|X_i)$ and conditional 80% confidence intervals. See Figure 10.3, page 206.
`xtfitg`	`xtfit` with Goodman's regression line superimposed.
`estsims`	All the simulated β_i^b's by all the simulated β_i^w's. The simulations should take roughly the same shape of the mean posterior contours, except for those sampled from outlier tomography lines.
`boundXb`	X_i by the bounds on β_i^b (each precinct appears as one vertical line), see the lines in the left graph in Figure 13.2, page 238.
`boundXw`	X_i by the bounds on β_i^w (each precinct appears as one vertical line), see the lines in the right graph in Figure 13.2, page 238.
`truth`	Compares truth to estimates at the district and precinct-level. Requires `truth` in the `ei` object. See Figures 10.4 (page 208) and 10.5 (page 210).
`movieD`	For each observation, one tomography plot appears with the line for the particular observation darkened. After the graph for each observation appears, the user can choose to view the next observation (hit return), jump to a specific observation number (type in the number and hit return), or stop (hit "s" and return).

`movie` For each observation, one page of graphics appears with the posterior distribution of β_i^b and β_i^w and a plot of the simulated values of β_i^b and β_i^w from the tomography line. The user can choose to view the next observation (hit return), jump to a specific observation number (type in the number and hit return), or stop (hit "s" and return).

Author(s)

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References

Gary King (1997). A Solution to the Ecological Inference Problem. Princeton: Princeton University Press.

Examples

```
data(sample)
formula = t ~ x
dbuf <- ei(formula=formula, total="n",data=sample)
plot(dbuf, "tomog")
plot(dbuf, "tomog", "betab", "betaw", "xtfit")
```

`RxCdata` *Sample Dataset*

Description

A description for this dataset

Usage

```
RxCdata
```

Format

A data frame containing 60 observations.

Source

Source

References

Gary King (1997). *A Solution to the Ecological Inference Problem.* Princeton: Princeton University Press.

sample *Sample Data for Black Votes*

Description

A description for this dataset

Usage

```
sample
```

Format

A vector containing 141 observations.

Source

Source

References

Gary King (1997). *A Solution to the Ecological Inference Problem.* Princeton: Princeton University Press.

summary.ei *Summarize Ecological Inference Estimates*

Description

'summary' method for the class 'ei'.

Usage

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

Arguments

object	An ei object from the function ei.
...	A list of options to return in graphs. See values below.

Author(s)

Gary King «email: king@harvard.edu» and Molly Roberts «email: molly.e.roberts@gmail.com»

References

Gary King (1997). A Solution to the Ecological Inference Problem. Princeton: Princeton University Press.

Examples

```
data(sample)
formula = t ~ x
dbuf <- ei(formula=formula, total="n",data=sample)
print(summary(dbuf))
```

---

tomogRxC *Plotting Ecological Inference Estimates with eiRxC information*

Description

A tomography plot for an estimated Ecological Inference model in RxC data.

Usage

```
tomogRxC(formula, data, total=NULL, refine=100)
```

Arguments

formula	A formula of the form cbind(col1, col2,...)~cbind(row1,row2,...)
data	data that contains the data that corresponds to the formula
total	'total' is the name of the variable in the dataset that contains the number of individuals in each unit
refine	specifies the amount of refinement for the image. Higher numbers mean better resolution.

Author(s)

Gary King «email: king@harvard.edu» and Molly Roberts «email: molly.e.roberts@gmail.com»

References

Gary King (1997). A Solution to the Ecological Inference Problem. Princeton: Princeton University Press.

Examples

```
data(RxCdata)
formula = cbind(turnout, noturnout) ~ cbind(white, black,hisp)
tomogRxC(formula, data=RxCdata)
```

tomogRxC3d *Plotting 2x3 Ecological Inference Estimates in 3 dimensions*

Description

A tomography plot in 3 dimensions for RxC Ecological Inference data and an estimated Ecological Inference model in RxC data.

Usage

```
tomogRxC3d(formula, data, total=NULL, lci=TRUE, estimates=FALSE, ci=FALSE, level=.95,
seed=1234, color=hcl(h=30,c=100,l=60), transparency=.75, light=FALSE, rotate=TRUE)
```

Arguments

formula	A formula of the form cbind(col1, col2,...)~cbind(row1,row2,...)
data	data that contains the data that corresponds to the formula
total	'total' is the name of the variable in the dataset that contains the number of individuals in each unit
lci	logical value specifying the use of the Law of Conservation of Ink, where the implicit information in the data is represented through color gradients, i.e. the color of the plane is a function of the area of the tomography plane.
estimates	logical value specifying whether the point estimates of β's are included for each observation on the tomography plot.
ci	logical value specifying whether the estimated confidence ellipse is included on the tomography plot.
level	numeric value from 0 to 1 specifying the significance level of the confidence ellipse; eg. .95 refers to 95% confidence ellipse.
seed	seed value for model estimation.
color	color of tomography planes if lci=F.
transparency	numeric value from 0 to 1 specifying transparency of tomography planes; 0 is entirely transparent.
light	logical value specifying whether lights should be included in the rgl interface. The inclusion of lights will create shadows in the plot that may distort colors.
rotate	logical value specifying whether the plot will rotate for 20 seconds.

Details

Requires rgl package and rgl viewer.

Author(s)

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References

Gary King (1997). A Solution to the Ecological Inference Problem. Princeton: Princeton University Press.

Examples

```
data(RxCdata)
formula <- cbind(turnout, noturnout) ~ cbind(white, black, hisp)
tomogRxC3d(formula, RxCdata, total=NULL, lci=TRUE, estimates=TRUE, ci=TRUE, transparency=.5,
light=FALSE, rotate=FALSE)
```

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