

Package ‘genius’

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Title G-Estimation under No-Interaction with Unmeasured Selection

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Description This package implements the MR GENIUS estimator.

Depends R (>= 3.4.1)

License GPL-3

Encoding UTF-8

LazyData true

RoxygenNote 6.0.1

Imports gmm (>= 1.6-1)

Suggests knitr,
rmarkdown

VignetteBuilder knitr

R topics documented:

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genius_addY	<i>MR GENIUS under additive outcome model</i>
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Description

Implements MR GENIUS under an additive outcome model.

Usage

```
genius_addY(Y, A, G, formula = A ~ G, alpha = 0.05, lower = -10,  
upper = 10)
```

Arguments

Y	A numeric vector of outcomes.
A	A numeric vector of exposures (binary values should be coded in 0/1).
G	A numeric matrix of instruments; each column stores values for one instrument (a numeric vector if only a single instrument is available).
formula	An object of class "formula" describing the linear predictor of the model for $E(A G)$ (default $A \sim G$, main effects of all available instruments).
alpha	Significance level for confidence interval (default value=0.05).
lower	The lower end point of the causal effect interval to be searched (default value=-10).
upper	The upper end point of the causal effect interval to be searched (default value=10).

Details

This function implements the estimators given in equations (6) and (12) of Tchetgen Tchetgen et al (2017) for single and multiple instruments, respectively. The term $E(A|G)$ is modelled under the logit and identity links for binary and continuous exposure respectively, with a default linear predictor consisting of the main effects of all available instruments.

Value

A "genius" object containing the following items:

beta.est	The point estimate of the causal effect (on the additive scale) of the exposure on the outcome.
beta.var	The corresponding estimated variance.
ci	The corresponding Wald-type confidence interval at specified significance level.
pval	The p-value for two-sided Wald test of null causal effect (on the additive scale) of the exposure on the outcome.

References

Tchetgen Tchetgen, E., Sun, B. and Walter, S. (2017). [The GENIUS Approach to Robust Mendelian Randomization Inference](#). arXiv e-prints.

Examples

```
# the following packages are needed to simulate data
library("msm")
library("MASS")
expit <- function(x) {
  exp(x)/(1+exp(x))
}

### example with binary exposure, all instruments invalid ###
# true causal effect, beta = 1.0
# Number of instruments, nIV = 10
# Y: vector of outcomes
# A: vector of exposures
# G: matrix of instruments, one column per instrument

nIV=10; N=5000; beta=1;
```

```

phi=rep(-0.02,nIV); gamma=rep(-0.15,nIV); alpha=rep(-0.5,nIV);
Gn = mvrnorm(N,rep(0,nIV),diag(rep(1,nIV)))

G = (Gn>0)*1;
U= as.vector(phi%*%t(G))+ rtnorm(n=N,mean=0.35,lower=0.2,upper=0.5);
A = rbinom(N,1,expit(as.vector(gamma%*%t(G))+U-0.35-as.vector(phi%*%t(G))));
Y = as.vector(alpha%*%t(G)) + beta*A + U + rnorm(N);

genius_addY(Y,A,G);

### specify a more richly parameterized linear predictor for the model
### of E[A|G] containing all main effects and pairwise interactions of
### instruments

colnames(G)=paste("g",1:10,sep="")

genius_addY(Y,A,G,A~(g1+g2+g3+g4+g5+g6+g7+g8+g9+g10)^2);

### example with continous exposure, all instruments invalid ###

nIV=10; N=500; beta=1;
phi=rep(-0.5,nIV); gamma=rep(-2,nIV); alpha=rep(-0.5,nIV);
lambda0=1; lambda1=rep(0.5,nIV);
Gn = mvrnorm(N,rep(0,nIV),diag(rep(1,nIV)))

G = (Gn>0)*1;
U = as.vector(phi%*%t(G))+rnorm(N);
A = as.vector(gamma%*%t(G)) +U + rnorm(N,mean=0,sd=abs(lambda0+as.vector(lambda1%*%t(G))));
Y = as.vector(alpha%*%t(G)) + beta*A + U + rnorm(N);

genius_addY(Y,A,G);

```

genius_mulY

*MR GENIUS under multiplicative outcome model***Description**

Implements MR GENIUS under a multiplicative outcome model.

Usage

```
genius_mulY(Y, A, G, formula = A ~ G, alpha = 0.05, lower = -10,
            upper = 10)
```

Arguments

Y	A numeric vector of outcomes.
A	A numeric vector of exposures (binary values should be coded in 0/1).
G	A numeric matrix of instruments; each column stores values for one instrument (a numeric vector if only a single instrument is available).
formula	An object of class "formula" describing the linear predictor of the model for $E(A G)$ (default $A \sim G$, main effects of all available instruments).

alpha	Significance level for confidence interval (default value=0.05).
lower	The lower end point of the causal effect interval to be searched (default value=-10).
upper	The upper end point of the causal effect interval to be searched (default value=10).

Details

This function implements MR GENIUS as the solution to the empirical version of equation (14) in Tchetgen Tchetgen et al (2017). The term $E(A|G)$ is modelled under the logit and identity links for binary and continuous exposure respectively, with a default linear predictor consisting of the main effects of all available instruments.

Value

A "genius" object containing the following items:

beta.est	The point estimate of the causal effect (on the multiplicative scale) of the exposure on the outcome.
beta.var	The corresponding estimated variance.
ci	The corresponding Wald-type confidence interval at specified significance level.
pval	The p-value for two-sided Wald test of null causal effect (on the multiplicative scale) of the exposure on the outcome.

References

Tchetgen Tchetgen, E., Sun, B. and Walter, S. (2017). [The GENIUS Approach to Robust Mendelian Randomization Inference](#). arXiv e-prints.

Examples

```
#the following packages are needed to simulate data
library("msm")
library("MASS")

### examples under multiplicative outcome model, all instruments invalid ###
# true causal effect, beta = 1.5
# Number of instruments, nIV = 10
# Y: vector of outcomes
# A: vector of exposures
# G: matrix of instruments, one column per instrument

### binary exposure
nIV=10; N=2000; beta=1.5;
phi=rep(-0.02,nIV); gamma=rep(-0.15,nIV); alpha=rep(-0.5,nIV);
Gn = mvrnorm(N,rep(0,nIV),diag(rep(1,nIV)))
G = (Gn>0)*1;
U= as.vector(phi%*%t(G))+ rtnorm(n=N,mean=0.35,lower=0.2,upper=0.5);
A = rbinom(N,1,expit(as.vector(gamma%*%t(G))+U-0.35-as.vector(phi%*%t(G))));
Y = exp(beta*A)*(as.vector(alpha%*%t(G)) + U) + rnorm(N);

genius_mulY(Y,A,G);

### specify a more richly parameterized linear predictor for the model of E[A|G]
### containing all main effects and pairwise interactions of instruments
```

```
colnames(G)=paste("g",1:10,sep="")

genius_mulY(Y,A,G,A~(g1+g2+g3+g4+g5+g6+g7+g8+g9+g10)^2);

### continuous exposure
nIV=10; N=2000; beta=1.5;
phi=rep(0.5,nIV); gamma=rep(0.5,nIV); alpha=rep(0.2,nIV);
lambda0=1; lambda1=rep(0.2,nIV);
Gn = mvrnorm(N,rep(0,nIV),diag(rep(1,nIV)))
G = (Gn>0)*1;
U = as.vector(phi%*%t(G))+rnorm(N);
A = as.vector(gamma%*%t(G)) +U + rnorm(N,mean=0,sd=abs(lambda0+as.vector(lambda1%*%t(G))));
Y = exp(beta*A)*(as.vector(alpha%*%t(G)) + U) + rnorm(N);

genius_mulY(Y,A,G);
```

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