

Package ‘MDEI’

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Type Package

Title Implementing the Method of Direct Estimation and Inference

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Description Causal and statistical inference on an arbitrary treatment effect curve requires care in both estimation and inference. This package, implements the Method of Direct Estimation and Inference as introduced in "Estimation and Inference on Nonlinear and Heterogeneous Effects" by Ratkovic and Tingley (2023) <[doi:10.1086/723811](https://doi.org/10.1086/723811)>. The method takes an outcome, variable of theoretical interest (treatment), and set of variables and then returns a partial derivative (marginal effect) of the treatment variable at each point along with uncertainty intervals. The approach offers two advances. First, a split-sample approach is used as a guard against over-fitting. Second, the method uses a data-driven interval derived from conformal inference, rather than relying on a normality assumption on the error terms.

License GPL (>= 2)

Depends R (>= 3.6.0)

Imports grDevices, MASS, ranger, Rcpp (>= 1.0.6), splines2

LinkingTo Rcpp, RcppArmadillo

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NeedsCompilation yes

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MDEI-package	<i>MDEI</i>
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Description

MDEI estimates effects.

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coverPlot	<i>Coverage Plot for MDEI Object</i>
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Description

Coverage Plot for MDEI Object

Usage

```
coverPlot(  
  object,  
  xvar = "treat",  
  sigval = 0,  
  target = "tau",  
  colors = c(gray(0.7), gray(0)),  
  cex.point = 0.5,  
  xlabel = "",  
  ylabel = "",  
  ...  
)
```

Arguments

object	An object of class MDEI.
xvar	The variable to plot along the x-axis. May be 'treat' for the treatment variable, the name of a column in the covariate matrix in the obj, or a numeric vector, the length of the data. Default is "treat".
sigval	The value to see if it is covered by the conformal interval. Either a single value or a vector. Default is 0.
target	Either tau' or 'theta'. The first, 'tau', is the marginal effect at each point, while the second 'theta', is the portion of the conditional mean of the outcome that is a function of the treatment and the outcome.
colors	A vector with two elements. The first is the color of the confidence interval at points where the conformal interval does not contain sigval, the second the color where it does. Default is c(gray(.7), gray(0)).
cex.point	The size of the points in the figure. Default is 0.5.
xlabel	Label for x-axis of figure. Default is "".
ylabel	Label for y-axis of figure. Default is "".
...	Additional arguments to be passed to plot.

Value

No return value.

MDEI

MDEI function

Description

Implements the Method of Direct Estimation and Inference

Usage

```
MDEI(
  y,
  treat,
  X,
  splits = 10,
  alpha = 0.9,
  samplesplit = TRUE,
  conformal = TRUE,
  nthreads.ranger = NULL,
  verbose = TRUE
)
```

Arguments

<code>y</code>	The outcome variable, a vector.
<code>treat</code>	The treatment variable, a vector.
<code>X</code>	A matrix of covariates.
<code>splits</code>	Number of repeated cross-fitting steps to implement.
<code>alpha</code>	The desired level of the confidence band.
<code>samplesplit</code>	Whether to use a sample splitting approach. Default is TRUE.
<code>conformal</code>	Whether to generate a conformal bands or use a critical value from the normal approximation. Default is TRUE..
<code>nthreads.ranger</code>	Number of threads used internally by the ranger function for random forests. Default is NULL.
<code>verbose</code>	An optional logical value. If TRUE information on the number of split samples completed is printed. Default is TRUE.

Value

tau.est The estimated marginal effect.

CIs.tau Upper and lower values of conformal confidence band.

critical.values Conformal critical values.

Ey.x Mean of outcome given only covariates.

coefficients The list of all nonparametric bases and the proportion of sample splits that they were selected.

internal Internal objects used for development and diagnostics.

References

Ratkovic, Marc and Dustin Tingley. 2023. "Estimation and Inference on Nonlinear and Heterogeneous Effects." *The Journal of Politics*.

Examples

```
n <- 100

X <- matrix(rnorm(n*1), nrow = n)
treat <- rnorm(n)
y <- treat^2 + X[,1] + rnorm(n)

# Be sure to run with more splits than this. We recommend
# at least 10-50 initially, for exploratory analyses, with several hundred for
# publication quality. For large sample sizes, these numbers may be adjusted down.
# These are only recommendations.
# Threads are set to 1 to pass CRAN checks, but we suggest leaving it at the default
# which ranger takes as the total number available.
set.seed(1)
m1 <- MDEI(y, treat, X, splits=1, alpha=.9, nthreads.ranger = 1)
```

```
# Accuracy
cor(m1$tau.est, treat*2)
cor(m1$theta.est, treat^2)

# Coverage
mean(apply(m1$CIs.tau-2*treat,1,prod)<0)
```

summary.MDEI	<i>Summary of an MDEI Object</i>
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Description

Summary of an object of class MDEI.

Usage

```
## S3 method for class 'MDEI'
summary(object, features = 10, ...)
```

Arguments

- object An object of class MDEI.
- features Number of spline bases to include.
- ... Additional arguments to be passed to plot.

Value

coefstable A table with three columns: the names of selected spline interactions, the average coefficient, and proportion of time it was included in the model. Averages over taken over subsamples in the split sample strategy. Note that the coefficients are interactions between spline interactions that can be accessed through `obj$internal$Xmat.spline`.

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