Package 'CIMTx'

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Type Package

Title Causal Inference for Multiple Treatments with a Binary Outcome

Version 0.3.0

Description Different methods to conduct causal inference for multiple treatments with a binary outcome, including regression adjustment, vector matching, Bayesian additive regression trees, targeted maximum likelihood and inverse probability of treatment weighting using different generalized propensity score models such as multinomial logistic regression, generalized boosted models and super learner. For more details, see the paper by Liangyuan Hu (2020) <doi:10.1177/0962280220921909>.

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R topics documented:

`bart_multiTrt` *Bayesian Additive Regression Trees (BART)*

Description

This function implements the BART method. Please use our main function causal_multi_treat.R.

Usage

```
bart_multiTrt(
  y,
  x,
  trt,
  discard = FALSE,
  estimand = "ATE",
  k = 2,
  ntree = 100,
  ndpost = parent.frame()$ndpost,
  nskip = 1000,
  reference = parent.frame()$reference_trt
)
```

Arguments

`y`	numeric vector for the binary outcome
`x`	dataframe including the treatment indicator and the covariates
`trt`	numeric vector for the treatment indicator
`discard`	discarding rules for BART method, inherited from causal_multi_treat.R
`estimand`	causal estimands. Please select "ATT" or "ATE"
`k`	For binary y, k is the number of prior standard deviations f(x) is away from +/-3. The bigger k is, the more conservative the fitting will be.

ntree	The number of trees in the sum
ndpost	The number of posterior draws returned
nskip	Number of MCMC iterations to be treated as burn in
reference	Reference group for ATT

Value

list with 2 elements for ATT effect. It contains

ATT12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATT13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
idata = data_gen(n = 5, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1] #exclude treatment indicator
y <- idata$Yobs
reference_trt <- 2
causal_multi_treat(y = y, x = all_vars,
trt = trt_ind, method = "BART", estimand = "ATT", discard = "No", ndpost = 10, reference_trt = 2)
```

---

bart_multiTrt_ate *Bayesian Additive Regression Trees (BART) for ATE estimation*

Description

This function implements the BART method when estimand is ATE. Please use our main function causal_multi_treat.R.

Usage

```
bart_multiTrt_ate(
  y,
  x,
  trt,
  k = 2,
  discard = "No",
  ntree = 100,
  ndpost = parent.frame()$ndpost,
  nskip = 1000
)
```

Arguments

y	numeric vector for the binary outcome
x	dataframe including the treatment indicator and the covariates
trt	numeric vector for the treatment indicator
k	For binary y, k is the number of prior standard deviations f(x) is away from +/-3. The bigger k is, the more conservative the fitting will be.
discard	discarding rules for BART method, inherited from causal_multi_treat.R
ntree	The number of trees in the sum
ndpost	The number of posterior draws returned
nskip	Number of MCMC iterations to be treated as burn in

Value

list with 2 elements for ATT effect. It contains

ATT12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATT13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
idata = data_gen(n = 3, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1] #exclude treatment indicator
y <- idata$Yobs
causal_multi_treat(y = y, x = idata$trtdat,
trt = trt_ind, method = "BART", estimand = "ATE", discard = "No", ndpost = 10)
```

`bart_multiTrt_att` *Bayesian Additive Regression Trees (BART) for ATT estimation*

Description

This function implements the BART method when estimand is ATT. Please use our main function causal_multi_treat.R.

Usage

```
bart_multiTrt_att(
  y,
  x,
  trt,
  k = 2,
  discard = "No",
  ntree = 100,
  ndpost = 1000,
  nskip = 1000,
  reference = parent.frame()$reference_trt
)
```

Arguments

`y`	numeric vector for the binary outcome
`x`	dataframe including the treatment indicator and the covariates
`trt`	numeric vector for the treatment indicator
`k`	For binary y, k is the number of prior standard deviations f(x) is away from +/-3. The bigger k is, the more conservative the fitting will be.
`discard`	discarding rules for BART method, inherited from causal_multi_treat.R
`ntree`	The number of trees in the sum
`ndpost`	The number of posterior draws returned
`nskip`	Number of MCMC iterations to be treated as burn in
`reference`	Reference group for ATT

Value

list with 2 elements for ATT effect. It contains

- `ATT12:` A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
- `ATT13:` A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATT effect. It contains

- `ATE12:` A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
- `ATE13:` A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
- `ATE23:` A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
idata = data_gen(n = 5, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1] #exclude treatment indicator
y <- idata$Yobs
causal_multi_treat(y = y, x = all_vars,
trt = trt_ind, method = "BART", estimand = "ATT", discard = "No", ndpost = 10, reference_trt = 2)
```

---

causal_multi_treat *Estimation of causal effects of multiple treatments*

Description

This function estimates the causal effects of multiple treatments with a binary outcome.

Usage

```
causal_multi_treat(
  y,
  x,
  trt,
  method,
  discard = "No",
  estimand,
  trim_alpha = 0.05,
  SL.library = c("SL.glm", "SL.gam", "SL.knn"),
  reference_trt = 1,
  ndpost = 1000
)
```

Arguments

y	numeric vector for the binary outcome
x	dataframe including the treatment indicator and the covariates
trt	numeric vector for the treatment indicator
method	methods for causal inference with multiple treatments. Please select one of the following methods: 1. Regression Adjustment: Logistics regression to impute missing outcomes 2. VM Matching: vector matching 3. BART: Bayesian Additive Regression Trees 4. TMLE: Targeted maximum likelihood 5. IPTW-Logistics: Inverse probability of treatment weighting (IPTW) with weights from logistics regression 6. IPTW-Logistics-Trim: IPTW with trimmed weights from logistics regression 7. IPTW-GBM: IPTW with weights from generalized boosted method 8. IPTW-GBM-Trim: IPTW with trimmed weights from generalized boosted method 9. IPTW-Superlearner: IPTW with weights from superlearner 10. IPTW-Superlearner-Trim: IPTW with trimmed weights from superlearner
discard	discarding rules for BART method. Please select "No", "Lenient" or "Stringent". The default is "No".
estimand	causal estimands. Please select "ATT" or "ATE"
trim_alpha	alpha values for IPTW weight trimming. The default is 0.05, which means we truncate upper 95% and lower 5% of the weights for further IPTW estimation. The default is a combination of SL.glm, SL.gam and SL.knn.
SL.library	methods specified with SL.library in Superlearner package
reference_trt	Reference group for ATT
ndpost	number of independent simulation draws to create

Value

list with 2 elements for ATT effect. It contains

ATT12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATT13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
idata = data_gen(n = 12, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1] #exclude treatment indicator
y <- idata$Yobs

# Regression Adjustment
causal_multi_treat(y = y, x = idata$trtdat,ndpost = 10,
trt = trt_ind, method ="Regression Adjustment", estimand = "ATT", reference_trt = 3)
causal_multi_treat(y = y, x = idata$trtdat,ndpost = 10,
trt = trt_ind, method ="Regression Adjustment",
estimand = "ATE")



# BART with and without discarding
## Not run:
causal_multi_treat(y = y, x = idata$trtdat,
trt = trt_ind, method = "BART", estimand = "ATE", discard = "No")
causal_multi_treat(y = y, x = idata$trtdat,
trt = trt_ind, method = "BART", estimand = "ATE", discard = "No")
causal_multi_treat(y = y, x = idata$trtdat,
trt = trt_ind, method = "BART", estimand = "ATT", discard = "Stringent")
causal_multi_treat(y = y, x = idata$trtdat,
trt = trt_ind, method = "BART", estimand = "ATT", discard = "Stringent")
causal_multi_treat(y = y, x = idata$trtdat,
trt = trt_ind, method = "BART", estimand = "ATT", discard = "Lenient")
causal_multi_treat(y = y, x = idata$trtdat,
trt = trt_ind, method = "BART", estimand = "ATT", discard = "Lenient")

# VM Matching
causal_multi_treat(y = y, x = idata$trtdat,
trt = trt_ind,method = "VM Matching", estimand = "ATT")

# IPTW-related methods
causal_multi_treat(y = y,trt = trt_ind,
method = "IPTW-Logistics", estimand = "ATT")
causal_multi_treat(y = y,trt = trt_ind,
method = "IPTW-Logistics", estimand = "ATE")
causal_multiple_treatment(y = y, x = idata$trtdat,
trt = trt_ind, method = "IPTW-GBM", estimand = "ATE")
causal_multiple_treatment(y = y, x = idata$trtdat,
trt = trt_ind, method = "IPTW-GBM-Trim", estimand = "ATE")
causal_multiple_treatment(y = y, x = idata$trtdat,
trt = trt_ind, method = "IPTW-Superlearner", estimand = "ATE")
causal_multiple_treatment(y = y, x = idata$trtdat,
trt = trt_ind, method = "IPTW-Superlearner-Trim", estimand = "ATE")
causal_multiple_treatment(y = y, x = idata$trtdat,
trt = trt_ind,method = "IPTW-Superlearner", estimand = "ATT")
causal_multiple_treatment(y = y, x = idata$trtdat,
```

```
trt = trt_ind, method = "IPTW-Superlearner-Trim", estimand = "ATT")


## End(Not run)
```

`data_gen` *Data generation function*

Description

This function generates data to test different causal inference methods.

Usage

```
data_gen(n, scenario, ratio, overlap, all_confounder)
```

Arguments

`n`	total number of units for simulation
`scenario`	simulation scenario 1 or scenario 2
`ratio`	ratio of units in the treatment groups
`overlap`	levels of covariate overlap: Please select: weak, strong, moderate
`all_confounder`	TRUE or FALSE. overlap is lacking for a variable that is not predictive of the outcome (all_confounder equals to TRUE) or situations when it is lacking for a true confounder (all_confounder equals to FALSE)

Value

list with the 5 elements. Nested within each list, it contains

`n:`	Number of units for simulation
`trt_ind:`	A data frame with number of rows equals to n and 11 columns
`Y:`	Observed binary outcome for 3 treatments
`Yobs:`	Observed binary outcome
`Est:`	True ATE/ATT for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
idata = data_gen(n = 120, ratio =1,scenario = 1)
```

data_gen_p1 *Data generation function for scenario 1*

Description

This function generates data to test different causal inference methods for scenario 1. Please use our main function data_gen.R

Usage

```
data_gen_p1(n = 11600, ratio = 3, all_confounder = FALSE)
```

Arguments

n	total number of units for simulation
ratio	ratio of units in the treatment groups
all_confounder	TRUE or FALSE. overlap is lacking for a variable that is not predictive of the outcome (all_confounder equals to TRUE) or situations when it is lacking for a true confounder (all_confounder equals to FALSE)

Value

list with the 5 elements. Nested within each list, it contains

n:	Number of units for simulation
trt_ind:	A data frame with number of rows equals to n and 11 columns
Y:	Observed binary outcome for 3 treatments
Yobs:	Observed binary outcome
Est:	True ATE/ATT for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
data_gen_p1(n = 116, ratio = 3,all_confounder=FALSE)
```

data_gen_p2 *Data generation function for scenario 2 This function generates data to test different causal inference methods for scenario 2. Please use our main function data_gen.R*

Description

Data generation function for scenario 2 This function generates data to test different causal inference methods for scenario 2. Please use our main function data_gen.R

Usage

```
data_gen_p2(n = 11600, p = 10, overlap = "weak", all_confounder = TRUE)
```

Arguments

n	total number of units for simulation
p	number of predictors
overlap	levels of covariate overlap: Please select: weak, strong, moderate
all_confounder	TRUE or FALSE. overlap is lacking for a variable that is not predictive of the outcome (all_confounder equals to TRUE) or situations when it is lacking for a true confounder (all_confounder equals to FALSE)

Value

list with the 5 elements. Nested within each list, it contains

n:	Number of units for simulation
trt_ind:	A data frame with number of rows equals to n and 11 columns
Y:	Observed binary outcome for 3 treatments
Yobs:	Observed binary outcome
Est:	True ATE/ATT for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
data_gen_p2(n = 116, p =10, overlap = "weak", all_confounder = TRUE)
```

expit *Inverse logit*

Description

This function inverse the logit function.

Usage

```
expit(x)
```

Arguments

x	a vector

Value

a vector

Examples

```
library(CIMTx)
expit(1:5)
```

iptw_multiTrt *Inverse probability of treatment weighting (IPTW)*

Description

This function implements the IPTW method. Please use our main function causal_multi_treat.R.

Usage

```
iptw_multiTrt(
  y,
  trt,
  psdat,
  estimand = "ATE",
  method,
  trim_alpha = parent.frame()$trim_alpha,
  SL.library = parent.frame()$SL.library,
  reference = parent.frame()$reference_trt
)
```

Arguments

y	numeric vector for the binary outcome
trt	numeric vector for the treatment indicator
psdat	data frame containing the treatment indicator and covariates
estimand	causal estimands, "ATT" or "ATE"
method	methods for causal inference with multiple treatments, inherited from causal_multi_treat.R
trim_alpha	alpha values for IPTW weight trimming, inherited from causal_multi_treat.R
SL.library	methods specified with SL.library in Superlearner package, inherited from causal_multi_treat.R
reference	Reference group for ATT

Value

list with 2 elements for ATT effect. It contains

ATT12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATT13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(1)
idata = data_gen(n = 500, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1] #exclude treatment indicator
y <- idata$Yobs
causal_multi_treat(y = y,trt = trt_ind,
method = "IPTW-Logistics", estimand = "ATT", reference_trt = 2)
```

`iptw_multiTrt_ate` *Inverse probability of treatment weighting for ATE estimation (IPTW)*

Description

This function implements the IPTW method when estimand is ATE. Please use our main function causal_multi_treat.R.

Usage

```
iptw_multiTrt_ate(y, trt_ind, psdat, method, trim_alpha, SL.library)
```

Arguments

`y`	numeric vector for the binary outcome
`trt_ind`	numeric vector for the treatment indicator
`psdat`	data frame containing the treatment indicator and covariates
`method`	methods for causal inference with multiple treatments, inherited from causal_multi_treat.R
`trim_alpha`	alpha values for IPTW weight trimming, inherited from causal_multi_treat.R
`SL.library`	methods specified with SL.library in Superlearner package, inherited from causal_multi_treat.R

Value

list with 2 elements for ATT effect. It contains

`ATT12:`	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
`ATT13:`	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

`ATE12:`	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
`ATE13:`	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
`ATE23:`	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(1)
idata = data_gen(n = 50, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1] #exclude treatment indicator
```

```
y <- idata$Yobs
iptw_multiTrt_ate(y=y, trt = trt_ind,SL.library = c("SL.glm"),
trim_alpha = 0.05, method = "IPTW-Logistics-Trim")
causal_multi_treat(y = y,trt = trt_ind,
method = "IPTW-Logistics", estimand = "ATE")
```

`iptw_multiTrt_att` *Inverse probability of treatment weighting for ATT estimation (IPTW)*

Description

This function implements the IPTW method when estimand is ATT. Please use our main function causal_multi_treat.R.

Usage

```
iptw_multiTrt_att(
  y,
  trt,
  psdat,
  method,
  trim_alpha,
  reference = parent.frame()$reference_trt,
  SL.library = parent.frame()$SL.library
)
```

Arguments

`y`	numeric vector for the binary outcome
`trt`	numeric vector for the treatment indicator
`psdat`	data frame containing the treatment indicator and covariates
`method`	methods for causal inference with multiple treatments, inherited from causal_multi_treat.R
`trim_alpha`	alpha values for IPTW weight trimming, inherited from causal_multi_treat.R
`reference`	Reference group for ATT
`SL.library`	methods specified with SL.library in Superlearner package, inherited from causal_multi_treat.R

Value

list with 2 elements for ATT effect. It contains

`ATT12:`	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
`ATT13:`	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(1)
idata = data_gen(n = 50, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1] #exclude treatment indicator
y <- idata$Yobs
reference_trt <- 2
causal_multi_treat(y = y,trt = trt_ind,
method = "IPTW-Logistics", estimand = "ATT", reference_trt = 2)
```

---

postSumm *Summarize posterior samples*

Description

This function summarize posterior samples of RD, RR and OR. Please use our main function causal_multi_treat.R.

Usage

```
postSumm(RD_est, RR_est, OR_est)
```

Arguments

RD_est	vector of estimation for RD
RR_est	vector of estimation for RR
OR_est	vector of estimation for OR

Value

list with 2 elements for ATT effect. It contains

ATT12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATT13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
postSumm(RD_est = 1:10, RR_est = 11:20, OR_est = 1:10)
```

---

regadj_multiTrt *Regression Adjustment*

Description

This function implements the regression adjustment method. Please use our main function causal_multi_treat.R.

Usage

```
regadj_multiTrt(
  y,
  x,
  trt,
  estimand = "ATE",
  ndpost = parent.frame()$ndpost,
  reference = parent.frame()$reference_trt
)
```

Arguments

y	numeric vector for the binary outcome
x	dataframe including the treatment indicator and the covariates
trt	numeric vector for the treatment indicator
estimand	causal estimands. Please select "ATT" or "ATE"
ndpost	number of independent simulation draws to create
reference	Reference group for ATT

Value

list with 2 elements for ATT effect. It contains

ATT12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATT13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
idata = data_gen(n = 12, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1]
y <- idata$Yobs
causal_multi_treat(y = y, x = idata$trtdat,ndpost = 10,
trt = trt_ind, method ="Regression Adjustment", estimand = "ATT", reference_trt = 3)
```

---

regadj_multiTrt_ate *Regression Adjustment when estimand is ATE*

Description

Regression Adjustment when estimand is ATE

Usage

```
regadj_multiTrt_ate(y, x, trt, ndpost = parent.frame()$ndpost)
```

Arguments

y	numeric vector for the binary outcome
x	dataframe including the treatment indicator and the covariates
trt	numeric vector for the treatment indicator
ndpost	number of independent simulation draws to create

Value

list with 2 elements for ATT effect. It contains

ATT12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATT13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
idata = data_gen(n = 12, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1]
y <- idata$Yobs
causal_multi_treat(y = y, x = idata$trtdat,ndpost = 10,
trt = trt_ind, method ="Regression Adjustment", estimand = "ATE")
```

---

regadj_multiTrt_att *Regression Adjustment when estimand is ATT*

Description

This function implements the regression adjustment method when estimand is ATT. Please use our main function causal_multi_treat.R.

Usage

```
regadj_multiTrt_att(
  y,
  x,
  trt,
  ndpost = parent.frame()$ndpost,
  reference = parent.frame()$reference_trt
)
```

Arguments

y	numeric vector for the binary outcome
x	dataframe including the treatment indicator and the covariates
trt	numeric vector for the treatment indicator
ndpost	number of independent simulation draws to create
reference	Reference group for ATT

Value

list with 2 elements for ATT effect. It contains

ATT12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATT13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(3242019)
idata = data_gen(n = 12, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1]
y <- idata$Yobs
reference_trt <- 2
regadj_multiTrt_att(y = y, x = idata$trtdat,trt = trt_ind, reference = 2, ndpost = 100)
```

---

tmle *Targeted maximum likelihood (TMLE)*

Description

This function implements the TMLE method. Please use our main function causal_multi_treat.R.

Usage

```
tmle(y, trt, x, ...)
```

Arguments

y	numeric vector for the binary outcome
trt	numeric vector for the treatment indicator
x	data frame containing the treatment indicator and covariates
...	Other arguments

Examples

```
library(CIMTx)
set.seed(3242019)
idata = data_gen(n = 120, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1] #exclude treatment indicator
y <- idata$Yobs
x = idata$trtdat
causal_multi_treat(y = y, x = idata$trtdat, trt = trt_ind,SL.library = c("SL.glm"),
method = "IPTW-Logistics", estimand = "ATE")
```

---

trunc_fun *Truncation*

Description

This function implements the truncation feature when estimand is ATT. Please use our main function causal_multi_treat.R.

Usage

```
trunc_fun(x, trim_alpha = 0.05)
```

Arguments

x	vector to be trimmed
trim_alpha	alpha values for IPTW weight trimming, inherited from causal_multi_treat.R

Value

vector trimmed

Examples

```
library(CIMTx)
trunc_fun(1:10)
```

vm_multiTrt_att *Vector matching Matching (VM matching)*

Description

This function implements the VM matching method. Please use our main function causal_multi_treat.R.

Usage

```
vm_multiTrt_att(y, x, trt, reference = parent.frame()$reference_trt)
```

Arguments

y	numeric vector for the binary outcome
x	dataframe including the treatment indicator and the covariates
trt	numeric vector for the treatment indicator
reference	Reference group for ATT

Value

list with 2 elements for ATT effect. It contains

ATT12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATT13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

list with 3 elements for ATE effect. It contains

ATE12:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE13:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR
ATE23:	A dataframe containing the estimation, standard error, lower and upper 95% CI for RD/RR/OR

Examples

```
library(CIMTx)
set.seed(1)
idata = data_gen(n = 120, ratio =1,scenario = 1)
trt_ind <- as.numeric(idata$trtdat$trt_ind)
all_vars <- idata$trtdat[, -1] #exclude treatment indicator
y <- idata$Yobs
causal_multi_treat(y = y, x = idata$trtdat,
trt = trt_ind,method = "VM Matching", estimand = "ATT", reference = 1)
```

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