Package ‘regmedint’

May 12, 2021

Title  Regression-Based Causal Mediation Analysis with an Interaction Term

Version  0.2.1

Description  ‘R’ implementation of the regression-based causal mediation analysis with a treatment-mediator interaction term, as originally implemented in the ‘SAS’ macro by Valeri and Vander-Weele (2013) <doi:10.1037/a0031034> and Valeri and Vander-Weele (2015) <doi:10.1097/EDE.0000000000000253>. Linear and logistic models are supported for the mediator model. Linear, logistic, loglinear, Poisson, negative binomial, Cox, and accelerated failure time (exponential and Weibull) models are supported for the outcome model.

License  GPL-2

Encoding  UTF-8

LazyData  true

Imports  Deriv, MASS, Matrix, assertthat, sandwich, survival

Suggests  boot, furrr, future, geepack, knitr, mice, mitools, modelr, purrr, rlang, rmarkdown, stringr, testthat, tidyverse

RoxygenNote  7.1.1

VignetteBuilder  knitr

URL  https://kaz-yos.github.io/regmedint/

BugReports  https://github.com/kaz-yos/regmedint/issues

Depends  R (>= 2.10)

NeedsCompilation  no

Author  Kazuki Yoshida [cre, aut] (<https://orcid.org/0000-0002-2030-3549>), Yi Li [ctb, aut] (<https://orcid.org/0000-0002-9359-210X>), Maya Mathur [ctb] (<https://orcid.org/0000-0001-6698-2607>)

Maintainer  Kazuki Yoshida <kazukiyoshida@mail.harvard.edu>

Repository  CRAN

Date/Publication  2021-05-12 04:30:02 UTC
beta_hat

R topics documented:

beta_hat ................................................................. 2
calc_myreg ............................................................. 3
calc_myreg_mreg_linear_yreg_linear ................................ 4
calc_myreg_mreg_linear_yreg_logistic ................................ 5
calc_myreg_mreg_logistic_yreg_linear ................................ 6
calc_myreg_mreg_logistic_yreg_logistic ................................ 7
coeff.regmedint ....................................................... 8
coeff.summary_regmedint .............................................. 9
confint.regmedint ..................................................... 10
fit_mreg ................................................................. 11
fit_yreg ................................................................. 12
grad_prop_med_yreg_linear ............................................ 13
grad_prop_med_yreg_logistic .......................................... 13
new_regmedint ......................................................... 14
print.regmedint ......................................................... 15
print.summary_regmedint .............................................. 16
prop_med_yreg_linear .................................................. 17
prop_med_yreg_logistic ................................................. 18
regmedint ............................................................ 19
report_missing ......................................................... 21
summary.regmedint .................................................... 22
summary.regmedint_mod_poisson ..................................... 23
theta_hat ............................................................... 24
validate_args .......................................................... 25
validate_regmedint .................................................... 26
vcov.regmedint ........................................................ 27
vcov.regmedint_mod_poisson .......................................... 28
vv2015 ................................................................. 28

Index 30

beta_hat

Create a vector of coefficients from the mediator model (mreg)

Description

This function extracts coef from mreg_fit and pads with zeros appropriately to create a named vector consistently having the following elements: (Intercept) avar cvar: This part is eliminated when cvar = NULL.

Usage

beta_hat(mreg, mreg_fit, avar, cvar)
calc_myreg

Arguments

mreg  A character vector of length 1. Mediator regression type: "linear" or "logistic".
mreg_fit  Model fit object for mreg (mediator model).
avar  A character vector of length 1. Treatment variable name.
cvar  A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.

Value

A named numeric vector of coefficients.

calc_myreg  

Description

This function returns functions that can be used to calculate the causal effect measures, given the mediator model fit (mreg_fit) and the outcome model fit (yreg_fit).

Usage

calc_myreg(mreg, mreg_fit, yreg, yreg_fit, avar, mvar, cvar, interaction)

Arguments

mreg  A character vector of length 1. Mediator regression type: "linear" or "logistic".
mreg_fit  Model fit from fit_mreg
yreg  A character vector of length 1. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp" or "survAFT_weibull".
yreg_fit  Model fit from fit_yreg
avar  A character vector of length 1. Treatment variable name.
mvar  A character vector of length 1. Mediator variable name.
cvar  A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.
interaction  A logical vector of length 1. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

Value

A list containing two functions. The first is for calculating point estimates. The second is for calculating the corresponding...
calc_myreg_mreg_linear_yreg_linear

Create calculators for effects and se (mreg linear / yreg linear)

Description

Construct functions for the conditional effect estimates and their standard errors in the mreg linear / yreg linear setting. Internally, this function deconstruct model objects and feed parameter estimates to the internal worker functions calc_myreg_mreg_linear_yreg_linear_est and calc_myreg_mreg_linear_yreg_linear_se.

Usage

calc_myreg_mreg_linear_yreg_linear(
  mreg,  
  mreg_fit, 
  yreg,  
  yreg_fit, 
  avar,  
  mvar,  
  cvar,  
  interaction
)

Arguments

mreg A character vector of length 1. Mediator regression type: "linear" or "logistic".
mreg_fit Model fit from fit_mreg
yreg A character vector of length 1. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".
yreg_fit Model fit from fit_yreg
avar A character vector of length 1. Treatment variable name.
mvar A character vector of length 1. Mediator variable name.
cvar A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.
interaction A logical vector of length 1. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

Value

A list containing a function for effect estimates and a function for corresponding standard errors.
calc_myreg_mreg_linear_yreg_logistic

Create calculators for effects and se (mreg linear / yreg logistic)

Description

Construct functions for the conditional effect estimates and their standard errors in the mreg linear / yreg logistic setting. Internally, this function deconstruct model objects and feed parameter estimates to the internal worker functions calc_myreg_mreg_linear_yreg_logistic_est and calc_myreg_mreg_linear_yreg_logistic_se.

Usage

    calc_myreg_mreg_linear_yreg_logistic(
        mreg, mreg_fit, yreg, yreg_fit, avar, mvar, cvar, interaction
    )

Arguments

mreg A character vector of length 1. Mediator regression type: "linear" or "logistic".
mreg_fit Model fit from fit_mreg
yreg A character vector of length 1. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".
yreg_fit Model fit from fit_yreg
avar A character vector of length 1. Treatment variable name.
mvar A character vector of length 1. Mediator variable name.
cvar A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.
interaction A logical vector of length 1. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

Value

A list containing a function for effect estimates and a function for corresponding standard errors.
calc_myreg_mreg_logistic_yreg_linear

Create calculators for effects and se (mreg logistic / yreg linear)

Description

Construct functions for the conditional effect estimates and their standard errors in the mreg logistic / yreg linear setting. Internally, this function deconstruct model objects and feed parameter estimates to the internal worker functions calc_myreg_mreg_logistic_yreg_linear_est and calc_myreg_mreg_logistic_yreg_linear_se.

Usage

calc_myreg_mreg_logistic_yreg_linear(
  mreg,
  mreg_fit,
  yreg,
  yreg_fit,
  avar,
  mvar,
  cvar,
  interaction
)

Arguments

- **mreg**: A character vector of length 1. Mediator regression type: "linear" or "logistic".
- **mreg_fit**: Model fit from `fit_mreg`
- **yreg**: A character vector of length 1. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".
- **yreg_fit**: Model fit from `fit_yreg`
- **avar**: A character vector of length 1. Treatment variable name.
- **mvar**: A character vector of length 1. Mediator variable name.
- **cvar**: A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.
- **interaction**: A logical vector of length 1. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

Value

A list containing a function for effect estimates and a function for corresponding standard errors.
Create calculators for effects and se (mreg logistic / yreg logistic)

Description

Construct functions for the conditional effect estimates and their standard errors in the mreg logistic / yreg logistic setting. Internally, this function deconstruct model objects and feed parameter estimates to the internal worker functions `calc_myreg_mreg_logistic_yreg_logistic_est` and `calc_myreg_mreg_logistic_yreg_logistic_se`.

Usage

```r
calc_myreg_mreg_logistic_yreg_logistic(
  mreg, 
  mreg_fit, 
  yreg, 
  yreg_fit, 
  avar, 
  mvar, 
  cvar, 
  interaction
)
```

Arguments

- **mreg**: A character vector of length 1. Mediator regression type: "linear" or "logistic".
- **mreg_fit**: Model fit from `fit_mreg`.
- **yreg**: A character vector of length 1. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".
- **yreg_fit**: Model fit from `fit_yreg`.
- **avar**: A character vector of length 1. Treatment variable name.
- **mvar**: A character vector of length 1. Mediator variable name.
- **cvar**: A character vector of length > 0. Covariate names. Use `NULL` if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.
- **interaction**: A logical vector of length 1. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

Value

A list contraining a function for effect estimates and a function for corresponding standard errors.
coef.regmedint

Extract point estimates.

Description

Extract point estimates evaluated at a0, a1, m_cde, and c_cond.

Usage

```r
## S3 method for class 'regmedint'
coef(object, a0 = NULL, a1 = NULL, m_cde = NULL, c_cond = NULL, ...)
```

Arguments

- `object`: An object of the `regmedint` class.
- `a0`: A numeric vector of length one.
- `a1`: A numeric vector of length one.
- `m_cde`: A numeric vector of length one. A mediator value at which the controlled direct effect (CDE) conditional on the adjustment covariates is evaluated. If not provided, the default value supplied to the call to `regmedint` will be used. Only the CDE is affected.
- `c_cond`: A numeric vector as long as the number of adjustment covariates. A set of covariate values at which the conditional natural effects are evaluated.
- `...`: For compatibility with the generic. Ignored.

Value

A numeric vector of point estimates.

Examples

```r
library(regmedint)
data(vv2015)
regmedint_obj <- regmedint(data = vv2015,
    ## Variables
    yvar = "y",
    avar = "x",
    mvar = "m",
    cvar = c("c"),
    eventvar = "event",
    ## Values at which effects are evaluated
    a0 = 0,
    a1 = 1,
    m_cde = 1,
    c_cond = 0.5,
    ## Model types
    mreg = "logistic",
```
yreg = "survAFT_weibull",
## Additional specification
interaction = TRUE,
casecontrol = FALSE)

coef(regmedint_obj)
## Evaluate at different values
coef(regmedint_obj, m_cde = 0, c_cond = 1)

---

**coef.summary_regmedint**

Extract the result matrix from a summary_regmedint object.

### Description

Extract the result matrix from a summary_regmedint object.

### Usage

```
## S3 method for class 'summary_regmedint'
coef(object, ...)
```

### Arguments

- **object**
  - An object with a class of summary_regmedint.
- **...**
  - For compatibility with the generic.

### Value

A matrix populated with results.

### Examples

```r
library(regmedint)
data(vv2015)
regmedint_obj <- regmedint(data = vv2015,
  ## Variables
  yvar = "y",
  avar = "x",
  mvar = "m",
  cvar = c("c"),
  eventvar = "event",
  ## Values at which effects are evaluated
  a0 = 0,
a1 = 1,
m_cde = 1,
c_cond = 0.5,
  ## Model types
  mreg = "logistic",
```
confint.regmedint

Description

Construct Wald approximate confidence intervals for the quantities of interest.

Usage

```
## S3 method for class 'regmedint'
confint(
  object,
  parm = NULL,
  level = 0.95,
  a0 = NULL,
  a1 = NULL,
  m_cde = NULL,
  c_cond = NULL,
  ...
)
```

Arguments

- **object** An object of the `regmedint` class.
- **parm** For compatibility with generic. Ignored.
- **level** A numeric vector of length one. Requested confidence level. Defaults to 0.95.
- **a0** A numeric vector of length one.
- **a1** A numeric vector of length one.
- **m_cde** A numeric vector of length one. A mediator value at which the controlled direct effect (CDE) conditional on the adjustment covariates is evaluated. If not provided, the default value supplied to the call to `regmedint` will be used. Only the CDE is affected.
- **c_cond** A numeric vector as long as the number of adjustment covariates. A set of covariate values at which the conditional natural effects are evaluated.
- **...** For compatibility with generic.

Value

A numeric matrix of the lower limit and upper limit.
Examples

```r
library(regmedint)
data(vv2015)
regmedint_obj <- regmedint(data = vv2015,
## Variables
yvar = "y",
avar = "x",
mvar = "m",
cvar = c("c"),
eventvar = "event",
## Values at which effects are evaluated
a0 = 0,
a1 = 1,
m_cde = 1,
c_cond = 0.5,
## Model types
mreg = "logistic",
yreg = "survAFT_weibull",
## Additional specification
interaction = TRUE,
casecontrol = FALSE)
confint(regmedint_obj)
## Evaluate at different values
confint(regmedint_obj, m_cde = 0, c_cond = 1)
## Change confidence level
confint(regmedint_obj, m_cde = 0, c_cond = 1, level = 0.99)
```

Description

lm is called if mreg = "linear". glm is called with family = binomial() if mreg = "logistic".

Usage

```r
fit_mreg(mreg, data, avar, mvar, cvar)
```

Arguments

- `mreg` A character vector of length 1. Mediator regression type: "linear" or "logistic".
- `data` Data frame containing the relevant variables.
- `avar` A character vector of length 1. Treatment variable name.
- `mvar` A character vector of length 1. Mediator variable name.
- `cvar` A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.
**Value**

A regression object of class lm (linear) or glm (logistic)

---

**fit_yreg**

Fit a model for the outcome given the treatment, mediator, and covariates.

---

**Description**

The outcome model type `yreg` can be one of the following "linear", "logistic", "loglinear" (implemented as modified Poisson), "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".

**Usage**

`fit_yreg(yreg, data, yvar, avar, mvar, cvar, eventvar, interaction)`

**Arguments**

- **yreg**
  A character vector of length 1. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".

- **data**
  Data frame containing the relevant variables.

- **yvar**
  A character vector of length 1. Outcome variable name. It should be the time variable for survival outcomes.

- **avar**
  A character vector of length 1. Treatment variable name.

- **mvar**
  A character vector of length 1. Mediator variable name.

- **cvar**
  A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if `avar` is randomized, `mvar` is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between `mvar` and `yvar`.

- **eventvar**
  An character vector of length 1. Only required for survival outcome regression models. Note that the coding is 1 for event and 0 for censoring, following the R survival package convention.

- **interaction**
  A logical vector of length 1. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

**Details**

The outcome regression functions to be called are the following:

- "linear" `lm`
- "logistic" `glm`
- "loglinear" `glm` (modified Poisson)
- "poisson" `glm`
- "negbin" `glm.nb`
- "survCox" `coxph`
- "survAFT_exp" `survreg`
- "survAFT_weibull" `survreg`
Value

Model fit object from one of the above regression functions.

Description

Calculate the gradient of the proportion mediated for yreg linear case.

Usage

\texttt{grad\_prop\_med\_yreg\_linear(pnde, tnie)}

Arguments

\begin{itemize}
  \item \texttt{pnde} \quad A numeric vector of length one. Pure natural direct effect.
  \item \texttt{tnie} \quad A numeric vector of length one. Total natural indirect effect.
\end{itemize}

Value

A numeric vector of length two. Gradient of the proportion mediated with respect to \texttt{pnde} and \texttt{tnie}.

---

\texttt{grad\_prop\_med\_yreg\_logistic}

\textit{Calculate the gradient of the proportion mediated for \texttt{yreg logistic}.}

Description

Calculate the gradient of the proportion mediated for yreg logistic case.

Usage

\texttt{grad\_prop\_med\_yreg\_logistic(pnde, tnie)}

Arguments

\begin{itemize}
  \item \texttt{pnde} \quad A numeric vector of length one. Pure natural direct effect.
  \item \texttt{tnie} \quad A numeric vector of length one. Total natural indirect effect.
\end{itemize}

Value

A numeric vector of length two. Gradient of the proportion mediated with respect to \texttt{pnde} and \texttt{tnie}.
new_regmedint

Low level constructor for a regmedint S3 class object.

Description

This is not a user function and meant to be executed within the regmedint function after validating the arguments.

Usage

new_regmedint(
  data,
  yvar,
  avar,
  mvar,
  cvar,
  eventvar,
  a0,
  a1,
  m_cde,
  c_cond,
  yreg,
  mreg,
  interaction,
  casecontrol
)

Arguments

data Data frame containing the relevant variables.
yvar A character vector of length 1. Outcome variable name. It should be the time variable for survival outcomes.
avar A character vector of length 1. Treatment variable name.
mvar A character vector of length 1. Mediator variable name.
cvar A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.

eventvar An character vector of length 1. Only required for survival outcome regression models. Note that the coding is 1 for event and 0 for censoring, following the R survival package convention.
a0 A numeric vector of length 1. Reference level of treatment variable that is considered "untreated" or "unexposed".
a1 A numeric vector of length 1.
The `print.regmedint` function is a print method for the `regmedint` object, designed to display the mediator regression (`mreg_fit`), outcome regression (`yreg_fit`), and the mediation analysis effect estimates.

### Arguments

- `x`  
  An object of the `regmedint` class.

- `a0`  
  A numeric vector of length one.

- `a1`  
  A numeric vector of length one.

- `m_cde`  
  A numeric vector of length one. A mediator value at which the controlled direct effect (CDE) conditional on the adjustment covariates is evaluated. If not provided, the default value supplied to the call to `regmedint` will be used. Only the CDE is affected.

- `c_cond`  
  A numeric vector of the same length as `cvar`. Covariate vector at which conditional effects are evaluated at.

- `yreg`  
  A character vector of length one. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".

- `mreg`  
  A character vector of length one. Mediator regression type: "linear" or "logistic".

- `interaction`  
  A logical vector of length one. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

- `casecontrol`  
  A logical vector of length one. Default to FALSE. Whether data comes from a case-control study.

### Value

A `regmedint` object.
c_cond  A numeric vector as long as the number of adjustment covariates. A set of covariate values at which the conditional natural effects are evaluated.

args_mreg_fit  A named list of argument to be passed to the method for the mreg_fit object.

args_yreg_fit  A named list of argument to be passed to the method for the mreg_fit object.

...  For compatibility with the generic. Ignored.

Value

Invisibly return the regmedint class object as is.

Examples

library(regmedint)
data(vv2015)
regmedint_obj <- regmedint(data = vv2015,
  ## Variables
  yvar = "y",
  avar = "x",
  mvar = "m",
  cvar = c("c"),
  eventvar = "event",
  ## Values at which effects are evaluated
  a0 = 0,
  a1 = 1,
  m_cde = 1,
  c_cond = 0.5,
  ## Model types
  mreg = "logistic",
  yreg = "survAFT_weibull",
  ## Additional specification
  interaction = TRUE,
  casecontrol = FALSE)

## Implicit printing
regmedint_obj
## Explicit printing
print(regmedint_obj)
## Evaluate at different values
print(regmedint_obj, m_cde = 0, c_cond = 1)
Usage

```r
## S3 method for class 'summary_regmedint'
print(x, ...)
```

Arguments

- `x`: An object of the class `summary_regmedint`
- `...`: For compatibility with the generic function.

Value

Invisibly return the first argument.

Examples

```r
library(regmedint)
data(vv2015)
regmedint_obj <- regmedint(data = vv2015,
  yvar = "y",
  avar = "x",
  mvar = "m",
  cvar = c("c"),
  eventvar = "event",
  a0 = 0,
  a1 = 1,
  m_cde = 1,
  c_cond = 0.5,
  mreg = "logistic",
  yreg = "survAFT_weibull",
  interaction = TRUE,
  casecontrol = FALSE)

summary(regmedint_obj)
print(summary(regmedint_obj))
```

Description

Calculate the proportion mediated for \( y \) linear.
prop_med_yreg_logistic

Usage

prop_med_yreg_linear(pnde, tnie)

Arguments

pnde Pure natural direct effect.

tnie Total natural indirect effect.

Value

Proportion mediated value.

Description

Calculate the approximate proportion mediated on the risk difference scale.

Usage

prop_med_yreg_logistic(pnde, tnie)

Arguments

pnde Pure natural direct effect on the log scale.

tnie Total natural indirect effect on the log scale.

Value

Proportion mediated value.
Description

The package is a simple R implementation of the SAS macro as described in Valeri & VanderWeele 2013 and Valeri & VanderWeele 2015 https://www.hsph.harvard.edu/tyler-vanderweele/tools-and-tutorials/.

This is a user-interface for regression-based causal mediation analysis as described in Valeri & VanderWeele 2013 and Valeri & VanderWeele 2015.

Usage

regmedint(
  data,
  yvar,
  avar,
  mvar,
  cvar,
  eventvar = NULL,
  a0,
  a1,
  m_cde,
  c_cond,
  mreg,
  yreg,
  interaction = TRUE,
  casecontrol = FALSE,
  na_omit = FALSE
)

Arguments

data          Data frame containing the relevant variables.
yvar          A character vector of length 1. Outcome variable name. It should be the time variable for survival outcomes.
avar          A character vector of length 1. Treatment variable name.
mvar          A character vector of length 1. Mediator variable name.
cvar          A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.
eventvar      An character vector of length 1. Only required for survival outcome regression models. Note that the coding is 1 for event and 0 for censoring, following the R survival package convention.
regmedint

a0  A numeric vector of length 1. Reference level of treatment variable that is considered "untreated" or "unexposed".

a1  A numeric vector of length 1.

m_cde  A numeric vector of length 1. Mediator level at which controlled direct effect is evaluated at.

c_cond  A numeric vector of the same length as cvar. Covariate vector at which conditional effects are evaluated at.

mreg  A character vector of length 1. Mediator regression type: "linear" or "logistic".

yreg  A character vector of length 1. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".

interaction  A logical vector of length 1. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

casecontrol  A logical vector of length 1. Default to FALSE. Whether data comes from a case-control study.

na_omit  A logical vector of length 1. Default to FALSE. Whether to use na.omit() function in stats package to remove NAs in columns of interest before fitting the models.

Value

regmedint object, which is a list containing the mediator regression object, the outcome regression object, and the regression-based mediation results.

Fitting models

Use the regmedint function to fit models and set up regression-based causal mediation analysis.

Examining results

Several methods are available to examine the regmedint object. print summary coef confint FIXME: Document once implemented.

Examples

library(regmedint)
data(vv2015)
regmedint_obj <- regmedint(data = vv2015,
## Variables
  yvar = "y",
  avar = "x",
  mvar = "m",
  cvar = c("c"),
  eventvar = "event",
## Values at which effects are evaluated
  a0 = 0,
  a1 = 1,
  m_cde = 1,
  c_cond = 0.5,
## Model types
mreg = "logistic",
yreg = "survAFT_weibull",
## Additional specification
interaction = TRUE,
casecontrol = FALSE)

summary(regmedint_obj)

---

report_missing

Report variables with missing data

**Description**

Report the number of missing observations for each variables of interest relevant for the analysis

**Usage**

```r
report_missing(data, yvar, avar, mvar, cvar, eventvar)
```

**Arguments**

data: Data frame containing the relevant variables.
yvar: A character vector of length 1. Outcome variable name. It should be the time variable for survival outcomes.
avar: A character vector of length 1. Treatment variable name.
mvar: A character vector of length 1. Mediator variable name.
cvar: A character vector of length > 0. Covariate names. Use `NULL` if there is no covariate. However, this is a highly suspicious situation. Even if `avar` is randomized, `mvar` is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between `mvar` and `yvar`.
eventvar: An character vector of length 1. Only required for survival outcome regression models. Note that the coding is 1 for event and 0 for censoring, following the R survival package convention.

**Value**

No return value, called for side effects.
## summary.regmedint

**summary method for regmedint object**

### Description
Summarize the mreg_fit, yreg_fit, and the mediation analysis effect estimates.

### Usage
```r
## S3 method for class 'regmedint'
summary(
  object,
  a0 = NULL,
  a1 = NULL,
  m_cde = NULL,
  c_cond = NULL,
  args_mreg_fit = list(),
  args_yreg_fit = list(),
  exponentiate = FALSE,
  level = 0.95,
  ...
)
```

### Arguments
- **object** An object of the `regmedint` class.
- **a0** A numeric vector of length one.
- **a1** A numeric vector of length one.
- **m_cde** A numeric vector of length one. A mediator value at which the controlled direct effect (CDE) conditional on the adjustment covariates is evaluated. If not provided, the default value supplied to the call to `regmedint` will be used. Only the CDE is affected.
- **c_cond** A numeric vector as long as the number of adjustment covariates. A set of covariate values at which the conditional natural effects are evaluated.
- **args_mreg_fit** A named list of argument to be passed to the method for the `mreg_fit` object.
- **args_yreg_fit** A named list of argument to be passed to the method for the `mreg_fit` object.
- **exponentiate** Whether to add exponentiated point and confidence limit estimates. When yreg = "linear", it is ignored.
- **level** Confidence level for the confidence intervals.
- **...** For compatibility with the generic. Ignored.

### Value
A `summary_regmedint` object, which is a list containing the summary objects of the `mreg_fit` and the `yreg_fit` as well as the mediation analysis results.
Examples

```r
library(regmedint)
data(vv2015)
regmedint_obj <- regmedint(data = vv2015,
## Variables
yvar = "y",
avar = "x",
mvar = "m",
cvar = c("c"),
eventvar = "event",
## Values at which effects are evaluated
a0 = 0,
a1 = 1,
m_cde = 1,
c_cond = 0.5,
## Model types
mreg = "logistic",
yreg = "survAFT_weibull",
## Additional specification
interaction = TRUE,
casecontrol = FALSE)
## Detailed result with summary
summary(regmedint_obj)
## Add exponentiate results for non-linear outcome models
summary(regmedint_obj, exponentiate = TRUE)
## Evaluate at different values
summary(regmedint_obj, m_cde = 0, c_cond = 1)
## Change confidence level
summary(regmedint_obj, m_cde = 0, c_cond = 1, level = 0.99)
```

---

**summary.regmedint_mod_poisson**

*Summary with robust sandwich variance estimator for modified Poisson*

Description

This is a version of `summary.glm` modified to use the robust variance estimator `sandwich`.

Usage

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

Arguments

- `object` A model object of the class `regmedint_mod_poisson`
- `...` For compatibility with the generic.
Value

An object of the class summary.glm

theta_hat

Create a vector of coefficients from the outcome model (yreg)

Description

This function extracts coef from yreg_fit and pads with zeros appropriately to create a named vector consistently having the following elements: (Intercept): A zero element is added for yreg = "survCox" for which no intercept is estimated (the baseline hazard is left unspecified). avar mvar
avar:mvar: A zero element is added when interaction = FALSE. cvar: This part is eliminated when cvar = NULL.

Usage

theta_hat(yreg, yreg_fit, avar, mvar, cvar, interaction)

Arguments

yreg A character vector of length 1. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".

yreg_fit Model fit object for yreg (outcome model).

avar A character vector of length 1. Treatment variable name.

mvar A character vector of length 1. Mediator variable name.

cvar A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.

interaction A logical vector of length 1. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

Value

A named numeric vector of coefficients.
validate_args

Validate arguments to regmedint before passing to other functions

Description

Internal functions (usually) do not validate arguments, thus, we need to make sure informative errors are raised when the arguments are not safe for subsequent computation.

Usage

validate_args(
  data,
  yvar,
  avar,
  mvar,
  cvar,
  eventvar,
  a0,
  a1,
  m_cde,
  c_cond,
  mreg,
  yreg,
  interaction,
  casecontrol
)

Arguments

data  Data frame containing the relevant variables.
yvar  A character vector of length 1. Outcome variable name. It should be the time variable for survival outcomes.
avar  A character vector of length 1. Treatment variable name.
mvar  A character vector of length 1. Mediator variable name.
cvar  A character vector of length > 0. Covariate names. Use NULL if there is no covariate. However, this is a highly suspicious situation. Even if avar is randomized, mvar is not. Thus, there should usually be some confounder(s) to account for the common cause structure (confounding) between mvar and yvar.

eventvar  An character vector of length 1. Only required for survival outcome regression models. Note that the coding is 1 for event and 0 for censoring, following the R survival package convention.
a0  A numeric vector of length 1. Reference level of treatment variable that is considered "untreated" or "unexposed".
a1  A numeric vector of length 1.
m_cde: A numeric vector of length 1. Mediator level at which controlled direct effect is evaluated at.

c_cond: A numeric vector of the same length as cvar. Covariate vector at which conditional effects are evaluated at.

mreg: A character vector of length 1. Mediator regression type: "linear" or "logistic".

yreg: A character vector of length 1. Outcome regression type: "linear", "logistic", "loglinear", "poisson", "negbin", "survCox", "survAFT_exp", or "survAFT_weibull".

interaction: A logical vector of length 1. Default to TRUE. Whether to include a mediator-treatment interaction term in the outcome regression model.

casecontrol: A logical vector of length 1. Default to FALSE. Whether data comes from a case-control study.

Value

No return value, called for side effects.

validate_regmedint

Validate soundness of a regmedint object.

Description

Check the structure of a proposed regmedint object for soundness.

Usage

validate_regmedint(x)

Arguments

x: A regmedint object.

Value

No return value, called for side effects.
Extract variance estimates in the vcov form.

Description

Extract variance estimates evaluated at \( a_0 \), \( a_1 \), \( m_{cde} \), and \( c_{cond} \).

Usage

```r
## S3 method for class 'regmedint'
vcov(object, a0 = NULL, a1 = NULL, m_cde = NULL, c_cond = NULL, ...)
```

Arguments

- `object`: An object of the `regmedint` class.
- `a0`: A numeric vector of length one.
- `a1`: A numeric vector of length one.
- `m_cde`: A numeric vector of length one. A mediator value at which the controlled direct effect (CDE) conditional on the adjustment covariates is evaluated. If not provided, the default value supplied to the call to `regmedint` will be used. Only the CDE is affected.
- `c_cond`: A numeric vector as long as the number of adjustment covariates. A set of covariate values at which the conditional natural effects are evaluated.
- `...`: For compatibility with the generic. Ignored.

Value

A numeric matrix with the diagonals populated with variance estimates. Off-diagonals are NA since these are not estimated.

Examples

```r
library(regmedint)
data(vv2015)
regmedint_obj <- regmedint(data = vv2015,
                          ## Variables
yvar = "y",
avar = "x",
mvar = "m",
cvar = c("c"),
eventvar = "event",
## Values at which effects are evaluated
a0 = 0,
a1 = 1,
m_cde = 1,
c_cond = 0.5,
## Model types
```
mreg = "logistic",
yreg = "survAFT_weibull",
## Additional specification
interaction = TRUE,
casecontrol = FALSE)

vcov(regmedint_obj)
## Evaluate at different values
vcov(regmedint_obj, m_cde = 0, c_cond = 1)

vcov.regmedint_mod_poisson

Robust sandwich variance estimator for modified Poisson

Description

Provide robust sandwich variance-covariance estimate using sandwich.

Usage

## S3 method for class 'regmedint_mod_poisson'
vcov(object, ...)

Arguments

object          A model object of the class regmedint_mod_poisson
...

For compatibility with the generic.

Value

A variance-covariance matrix using the sandwich.

vv2015

Example dataset from Valeri and VanderWeele 2015.

Description


Usage

vv2015
Format

A tibble with 100 rows and 7 variables:

- **id** Positive integer id.
- **x** Binary treatment assignment variable.
- **m** Binary mediator variable.
- **y** Time to event outcome variable.
- **cens** Binary censoring indicator. Censored is 1.
- **c** Continuous confounder variable.
- **event** Binary event indicator. Event is 1.

Source

https://www.hsph.harvard.edu/tyler-vanderweele/tools-and-tutorials/
Index

* datasets
  vv2015, 28

beta_hat, 2

calc_myreg, 3
calc_myreg_mreg_linear_yreg_linear, 4
calc_myreg_mreg_linear_yreg_logistic, 5
calc_myreg_mreg_logistic_yreg_linear, 6
calc_myreg_mreg_logistic_yreg_logistic, 7
coeff, 2, 24
coeff.regmedint, 8
coeff.summary_regmedint, 9
confint.regmedint, 10
coxph, 12

fit_mreg, 3–7, 11
fit_yreg, 3–7, 12

glm, 11, 12
glm.nb, 12
grad_prop_med_yreg_linear, 13
grad_prop_med_yreg_logistic, 13

lm, 11, 12

new_regmedint, 14

print.regmedint, 15
print.summary_regmedint, 16
prop_med_yreg_linear, 17
prop_med_yreg_logistic, 18

regmedint, 8, 10, 15, 19, 22, 27
report_missing, 21

sandwich, 23, 28
summary.glm, 23

summary.regmedint, 16, 22
summary.regmedint_mod_poisson, 23
survreg, 12

theta_hat, 24

validate_args, 25
validate_regmedint, 26
vcov.regmedint, 27
vcov.regmedint_mod_poisson, 28
vv2015, 28