

# Package ‘caratREG’

August 16, 2021

**Type** Package

**Title** Regression Analysis Methods for Covariate-Adaptive Randomized Trials

**Version** 0.0.1

**Date** 2021-08-10

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## Description

This package implements all of the regression methods considered in Ma et al. (2020) for estimating and inferring the treatment effect under covariate-adaptive randomization.

**License** GPL (>= 3)

**Imports** dplyr (>= 1.0.0), MASS, stats

**RoxygenNote** 7.1.1

**NeedsCompilation** no

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caratREG-package	<i>Regression Analysis Methods for Covariate-Adaptive Randomized Trials</i>
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## Description

This package implements all of the regression methods considered in Ma et al. (2020) for estimating and inferring the treatment effect under covariate-adaptive randomization.

## Details

Index of help topics:

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tau.adj	Regression without interaction
tau.diff	Difference in means
tau.interact	Regression with interaction

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## References

Ma, W., Tu, F., & Liu, H. (2020). *Regression analysis for covariate-adaptive randomization: A robust and efficient inference perspective*. arXiv preprint arXiv:2009.02287.

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tau.adj	<i>Regression without interaction</i>
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## Description

Estimating and inferring the treatment effect based on regression without interaction.

## Usage

```
tau.adj(Y, A, B, X = NULL, pi, q, conf.level = 0.95)
```

## Arguments

Y	a numeric vector of observed outcomes. Its length should be the same as the number of subjects.
A	a numeric vector of treatment assignments. Its length should be the same as the number of subjects.
B	a numeric vector of stratum labels. Its length should be the same as the number of subjects.
X	an (optional) numeric design matrix containing additional covariates used in the regression.
pi	a numeric value for the target treatment proportion in each stratum.
q	a numeric value indicating the balance level of covariate-adaptive randomizations. Detailed information can be found in Section 2, Ma et al.(2020).
conf.level	confidence level of the interval. Default is 0.95.

## Details

Estimating and inferring the treatment effect based on regression without interaction. It implements the methods as described in Sections 3.2 and 4.2, Ma et al. (2020).

**Value**

A list of class "htest" containing the following components:

statistic	the value of the t-statistic.
p.value	the p-value for the test.
conf.int	a confidence interval under chosen level conf.level for the difference in treatment effect between treatment group and control group.
estimate	estimated treatment effect difference between treatment group and control group.
method	a character string indicating what type of regression was performed.

**References**

Ma, W., Tu, F., & Liu, H. (2020). *Regression analysis for covariate-adaptive randomization: A robust and efficient inference perspective*. arXiv preprint arXiv:2009.02287.

**Examples**

```
#The code replicates the simulation setting of Model 2 in Section 6, Ma et al. (2020).
n <- 1000
pi <- 0.5
q <- pi*(1-pi)
alphavec <- c(5,8,3,12)
m2e<-function(x){
  6*exp(x)*x*(1-x)
}
X1 <- rgamma(n,2)
X2 <- sample(c(1,2,3),n,replace = TRUE, prob = c(0.3,0.6,0.1))
X3 <- rpois(n,3)
X4 <- rbeta(n,2,2)
X1_S <- rep(1,n)
X1_S[which(X1 >= 2.5)] <- 2
B <- as.numeric(interaction(X1_S,X2))
X <- cbind(X1,X3)
A <- sample(c(0,1),n,replace=TRUE,prob=c(1-pi,pi))
Y0 <- alphavec[2]*3.6-alphavec[1]*2-alphavec[4]*integrate(m2e,lower = 0,upper = 1)$value +
  alphavec[1]*X1+log(alphavec[3]*X1*log(X3+1)+1)+alphavec[4]*exp(X4)+rnorm(n,sd = 2)
Y1 <- alphavec[2]*X2^2+log(alphavec[3]*X1*log(X3+1)+1)+rnorm(n,sd = 1)
Y <- Y0*(1-A)+Y1*A
tau.adj(Y, A, B, X, pi, q)
```

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tau.diff

*Difference in means*


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**Description**

Estimating and inferring the treatment effect based on difference in means.

**Usage**

```
tau.diff(Y, A, B, X = NULL, pi, q, conf.level = 0.95)
```

## Arguments

Y	a numeric vector of observed outcomes. Its length should be the same as the number of subjects.
A	a numeric vector of treatment assignments. Its length should be the same as the number of subjects.
B	a numeric vector of stratum labels. Its length should be the same as the number of subjects.
X	an (optional) numeric design matrix containing additional covariates used in the regression.
pi	a numeric value for the target treatment proportion in each stratum.
q	a numeric value indicating the balance level of covariate-adaptive randomizations. Detailed information can be found in Section 2, Ma et al.(2020).
conf.level	confidence level of the interval. Default is 0.95.

## Details

Estimating and inferring the treatment effect based on difference in means. It implements the methods as described in Sections 3.1 and 4.1, Ma et al. (2020).

## Value

A list of class "htest" containing the following components:

statistic	the value of the t-statistic.
p.value	the p-value for the test.
conf.int	a confidence interval under chosen level <code>conf.level</code> for the difference in treatment effect between treatment group and control group.
estimate	estimated treatment effect difference between treatment group and control group.
method	a character string indicating what type of regression was performed.

## References

Ma, W., Tu, F., & Liu, H. (2020). *Regression analysis for covariate-adaptive randomization: A robust and efficient inference perspective*. arXiv preprint arXiv:2009.02287.

## Examples

```
#The code replicates the simulation setting of Model 2 in Section 6, Ma et al. (2020).
n <- 1000
pi <- 0.5
q <- pi*(1-pi)
alphavec <- c(5,8,3,12)
m2e<-function(x){
  6*exp(x)*x*(1-x)
}
X1 <- rgamma(n,2)
X2 <- sample(c(1,2,3),n,replace = TRUE, prob = c(0.3,0.6,0.1))
X3 <- rpois(n,3)
X4 <- rbeta(n,2,2)
X1_S <- rep(1,n)
X1_S[which(X1 >= 2.5)] <- 2
```

```

B <- as.numeric(interaction(X1_S,X2))
X <- cbind(X1,X3)
A <- sample(c(0,1),n,replace=TRUE,prob=c(1-pi,pi))
Y0 <- alphavec[2]*3.6-alphavec[1]*2-alphavec[4]*integrate(m2e,lower = 0,upper = 1)$value+
  alphavec[1]*X1+log(alphavec[3]*X1*log(X3+1)+1)+alphavec[4]*exp(X4)+rnorm(n,sd = 2)
Y1 <- alphavec[2]*X2^2+log(alphavec[3]*X1*log(X3+1)+1)+rnorm(n,sd = 1)
Y <- Y0*(1-A)+Y1*A
tau.diff(Y, A, B, X, pi, q)

```

tau.interact

*Regression with interaction***Description**

Estimating and inferring the treatment effect based on regression with interaction.

**Usage**

```
tau.interact(Y, A, B, X = NULL, pi, conf.level = 0.95)
```

**Arguments**

Y	a numeric vector of observed outcomes. Its length should be the same as the number of subjects.
A	a numeric vector of treatment assignments. Its length should be the same as the number of subjects.
B	a numeric vector of stratum labels. Its length should be the same as the number of subjects.
X	an (optional) numeric design matrix containing additional covariates used in the regression.
pi	a numeric value for the target treatment proportion in each stratum.
conf.level	confidence level of the interval. Default is 0.95.

**Details**

Estimating and inferring the treatment effect based on regression with interaction. It implements the methods as described in Sections 3.3 and 4.3, Ma et al. (2020).

**Value**

A list of class "htest" containing the following components:

statistic	the value of the t-statistic.
p.value	the p-value for the test.
conf.int	a confidence interval under chosen level conf.level for the difference in treatment effect between treatment group and control group.
estimate	estimated treatment effect difference between treatment group and control group.
method	a character string indicating what type of regression was performed.

## References

Ma, W., Tu, F., & Liu, H. (2020). *Regression analysis for covariate-adaptive randomization: A robust and efficient inference perspective*. arXiv preprint arXiv:2009.02287.

## Examples

```
#The code replicates the simulation setting of Model 2 in Section 6, Ma et al. (2020).
n <- 1000
pi <- 0.5
alphavec <- c(5,8,3,12)
m2e<-function(x){
  6*exp(x)*x*(1-x)
}
X1 <- rgamma(n,2)
X2 <- sample(c(1,2,3),n,replace = TRUE, prob = c(0.3,0.6,0.1))
X3 <- rpois(n,3)
X4 <- rbeta(n,2,2)
X1_S <- rep(1,n)
X1_S[which(X1 >= 2.5)] <- 2
B <- as.numeric(interaction(X1_S,X2))
X <- cbind(X1,X3)
A <- sample(c(0,1),n,replace=TRUE,prob=c(1-pi,pi))
Y0 <- alphavec[2]*3.6-alphavec[1]*2-alphavec[4]*integrate(m2e,lower = 0,upper = 1)$value+
  alphavec[1]*X1+log(alphavec[3]*X1*log(X3+1)+1)+alphavec[4]*exp(X4)+rnorm(n,sd = 2)
Y1 <- alphavec[2]*X2^2+log(alphavec[3]*X1*log(X3+1)+1)+rnorm(n,sd = 1)
Y <- Y0*(1-A)+Y1*A
tau.interact(Y, A, B, X, pi)
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