

# Package ‘ipwErrorY’

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**Type** Package

**Title** Inverse Probability Weighted Estimation of Average Treatment Effect with Misclassified Binary Outcome

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**Author** Di Shu <shudi1991@gmail.com>, Grace Y. Yi <y yi@uwaterloo.ca>

**Maintainer** Di Shu <shudi1991@gmail.com>

**Description** An implementation of the correction methods proposed by Shu and Yi (2017) <doi:10.1177/0962280217743777> for the inverse probability weighted (IPW) estimation of average treatment effect (ATE) with misclassified binary outcomes. Logistic regression model is assumed for treatment model for all implemented correction methods, and is assumed for the outcome model for the implemented doubly robust correction method. Misclassification probability given a true value of the outcome is assumed to be the same for all individuals.

**License** GPL (>= 2)

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## R topics documented:

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| ipwErrorY-package | <i>Inverse Probability Weighted (IPW) Estimation of Average Treatment Effect (ATE) with Misclassified Binary Outcome</i> |
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## Description

This package is an implementation of the correction methods proposed by Shu and Yi (2017) for the inverse probability weighted (IPW) estimation of average treatment effect (ATE) with misclassified binary outcomes. Logistic regression model is assumed for treatment model for all implemented correction methods, and is assumed for the outcome model for the implemented doubly robust correction method. Misclassification probability given a true value of the outcome is assumed to be the same for all individuals.

## Details

The ipwErrorY package implements correction methods developed by Shu and Yi (2017) to adjust for misclassification in binary outcomes in the inverse probability weighted estimation of average treatment effect. The function `KnownError` implements the correction method with known outcome misclassification probabilities. The function `EstValidation` implements the optimal linear combination correction method when validation data are available. The function `Est2Replicates` implements the correction method when two independent replicates of the outcome are available. The function `KnownErrorDR` implements the doubly robust correction method with known outcome misclassification probabilities.

## Author(s)

Di Shu and Grace Y. Yi

Maintainer: Di Shu <shudi1991@gmail.com>

## References

Shu D, Yi GY. (2017). Causal inference with measurement error in outcomes: bias analysis and estimation methods. *Statistical Methods in Medical Research* <doi:10.1177/0962280217743777>

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| Est2Replicates | <i>Estimation of ATE with Two Replicates</i> |
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## Description

Estimation of average treatment effect when misclassification probabilities are unknown but two independent replicates of the outcome are available

**Usage**

```
Est2Replicates(data, indA, indYerror, indX,
  constraint = c("sensitivity equals specificity", "known sensitivity",
    "known specificity", "known prevalence"), sensitivity = NULL,
  specificity = NULL, prevalence = NULL, confidence = 0.95)
```

**Arguments**

|                          |   |
|--------------------------|---|
| <code>data</code>        | The dataset to be analyzed in the form of R data frame without missing data   |
| <code>indA</code>        | A column name indicating the binary treatment variable  |
| <code>indYerror</code>   | A vector of two column names indicating replicates of the binary outcome variable   |
| <code>indX</code>        | A vector of column names indicating the covariates included in the treatment model  |
| <code>constraint</code>  | The constraint to be used; the default assumes sensitivity equals specificity   |
| <code>sensitivity</code> | The specified sensitivity between 0 and 1 when imposing the constraint that sensitivity is known, and the default is set to be NULL |
| <code>specificity</code> | The specified specificity between 0 and 1 when imposing the constraint that specificity is known, and the default is set to be NULL |
| <code>prevalence</code>  | The specified prevalence between 0 and 1 when imposing the constraint that prevalence is known, and the default is set to be NULL   |
| <code>confidence</code>  | The confidence level between 0 and 1; the default is 0.95 corresponding to a 95 per cent confidence interval                        |

**Value**

A list of the estimate of average treatment effect, sandwich-variance-based standard error, confidence interval, imposed constraint, and the information on sensitivity and specificity

**Examples**

```
#create a dataset with sensitivity=0.95 and specificity=0.85
set.seed(100)
X1=rnorm(2000)
A=rbinom(2000,1,1/(1+exp(-0.2-X1)))
Y=rbinom(2000,1,1/(1+exp(-0.2-A-X1)))
y1=which(Y==1)
y0=which(Y==0)
Yast1=Y
Yast1[y1]=rbinom(length(y1),1,0.95)
Yast1[y0]=rbinom(length(y0),1,0.15)
Yast2=Y
Yast2[y1]=rbinom(length(y1),1,0.95)
Yast2[y0]=rbinom(length(y0),1,0.15)
da=data.frame(A=A,X1=X1,Yast1=Yast1,Yast2=Yast2)
head(da)
#apply the correction method assuming specificity=0.85
Est2Replicates(da,"A",c("Yast1","Yast2"),"X1","known specificity",NULL,0.85,NULL,0.95)
```

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 EstValidation

*Estimation of ATE with Validation Data*


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### Description

Estimation of average treatment effect using the optimal linear combination method when misclassification probabilities are unknown but validation data are available

### Usage

```
EstValidation(maindata, validationdata, indA, indYerror, indX, indY,
  confidence = 0.95)
```

### Arguments

|                |  |
|----------------|--|
| maindata       | The non-validation main data in the form of R data frame without missing data                                |
| validationdata | The validation data in the form of R data frame without missing data   |
| indA           | A column name indicating the binary treatment variable   |
| indYerror      | A column name indicating the misclassified binary outcome variable   |
| indX           | A vector of column names indicating the covariates included in the treatment model                           |
| indY           | A column name indicating the true binary outcome variable  |
| confidence     | The confidence level between 0 and 1; the default is 0.95 corresponding to a 95 per cent confidence interval |

### Value

A list of the estimate of average treatment effect, sandwich-variance-based standard error, confidence interval, and the estimated sensitivity and specificity

### Examples

```
#create main data and validation data with sensitivity=0.95 and specificity=0.85
set.seed(100)
X1=rnorm(1200)
A=rbinom(1200,1,1/(1+exp(-0.2-X1)))
Y=rbinom(1200,1,1/(1+exp(-0.2-A-X1)))
y1=which(Y==1)
y0=which(Y==0)
Yast=Y
Yast[y1]=rbinom(length(y1),1,0.95)
Yast[y0]=rbinom(length(y0),1,0.15)
mainda=data.frame(A=A,X1=X1,Yast=Yast)
X1=rnorm(800)
A=rbinom(800,1,1/(1+exp(-0.2-X1)))
Y=rbinom(800,1,1/(1+exp(-0.2-A-X1)))
y1=which(Y==1)
```

```

y0=which(Y==0)
Yast=Y
Yast[y1]=rbinom(length(y1),1,0.95)
Yast[y0]=rbinom(length(y0),1,0.15)
validationda=data.frame(A=A,X1=X1,Y=Y,Yast=Yast)
head(mainda)
head(validationda)
#apply the optimal linear combination correction method
EstValidation(mainda,validationda,"A","Yast","X1","Y",0.95)

```

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KnownError

*Estimation of ATE with Known Error*


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### Description

Estimation of average treatment effect with known outcome misclassification probabilities, i.e., known sensitivity and specificity

### Usage

```
KnownError(data, indA, indYerror, indX, sensitivity, specificity,
           confidence = 0.95)
```

### Arguments

|             |  |
|-------------|--|
| data        | The dataset to be analyzed in the form of R data frame without missing data                                  |
| indA        | A column name indicating the binary treatment variable   |
| indYerror   | A column name indicating the misclassified binary outcome variable   |
| indX        | A vector of column names indicating the covariates included in the treatment model                           |
| sensitivity | The specified sensitivity between 0 and 1  |
| specificity | The specified specificity between 0 and 1  |
| confidence  | The confidence level between 0 and 1; the default is 0.95 corresponding to a 95 per cent confidence interval |

### Value

A list of the estimate of average treatment effect, sandwich-variance-based standard error and confidence interval

**Examples**

```
#create a dataset with sensitivity=0.95 and specificity=0.85
set.seed(100)
X1=rnorm(2000)
A=rbinom(2000,1,1/(1+exp(-0.2-X1)))
Y=rbinom(2000,1,1/(1+exp(-0.2-A-X1)))
y1=which(Y==1)
y0=which(Y==0)
Yast=Y
Yast[y1]=rbinom(length(y1),1,0.95)
Yast[y0]=rbinom(length(y0),1,0.15)
da=data.frame(X1=X1,A=A,Yast=Yast)
head(da)
#apply the correction method with sensitivity=0.95 and specificity=0.85
KnownError(da,"A","Yast","X1",0.95,0.85,0.95)
```

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KnownErrorDR

*Doubly Robust Estimation of ATE with Known Error*


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**Description**

Doubly robust estimation of average treatment effect with known outcome misclassification probabilities, i.e., known sensitivity and specificity

**Usage**

```
KnownErrorDR(data, indA, indYerror, indXtrt, indXout, sensitivity, specificity,
  sharePara = FALSE, confidence = 0.95)
```

**Arguments**

|             |  |
|-------------|--|
| data        | The dataset to be analyzed in the form of R data frame without missing data  |
| indA        | A column name indicating the binary treatment variable   |
| indYerror   | A column name indicating the misclassified binary outcome variable   |
| indXtrt     | A vector of column names indicating the covariates included in the treatment model   |
| indXout     | A vector of column names indicating the covariates included in the outcome model   |
| sensitivity | The specified sensitivity between 0 and 1  |
| specificity | The specified specificity between 0 and 1  |
| sharePara   | if the treated and untreated groups share parameters for covariates in the logistic outcome model (i.e., assuming $Y \sim T+X$ ), then set sharePara=TRUE; if not (i.e., modeling $Y \sim X$ for the treated and untreated groups separately), then set sharePara=FALSE. By default, sharePara=FALSE |
| confidence  | The confidence level between 0 and 1; the default is 0.95 corresponding to a 95 per cent confidence interval   |

**Value**

A list of the estimate of average treatment effect, sandwich-variance-based standard error and confidence interval

**Examples**

```
#create a dataset with sensitivity=0.95 and specificity=0.85
set.seed(100)
X=rnorm(2000)
xx=X^2
A=rbinom(2000,1,1/(1+exp(-0.1-X-0.2*xx)))
Y=rbinom(2000,1,1/(1+exp(1-A-0.5*X-xx)))
y1=which(Y==1)
y0=which(Y==0)
Y[y1]=rbinom(length(y1),1,0.95)
Y[y0]=rbinom(length(y0),1,0.15)
Yast=Y
da=data.frame(A=A,X=X,xx=xx,Yast=Yast)
head(da)
#apply the doubly robust correction method with sensitivity=0.95 and specificity=0.85
KnownErrorDR(da,"A","Yast",c("X","xx"),c("X","xx"),0.95,0.85,FALSE,0.95)
```

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