

Package ‘predieval’

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Type Package

Title Assessing Performance of Prediction Models for Predicting Patient-Level Treatment Benefit

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Description Methods for assessing the performance of a prediction model with respect to identifying patient-level treatment benefit. All methods are applicable for continuous and binary outcomes, and for any type of statistical or machine-learning prediction model as long as it uses baseline covariates to predict outcomes under treatment and control.

License GPL (>= 2)

Depends R (>= 4.1)

Imports stats, Hmisc (>= 4.6-0), ggplot2 (>= 3.3.5), MASS (>= 7.3), Matching (>= 4.10-2)

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URL <https://github.com/esm-ism-unibe-ch/predieval>

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bencalibr	<i>Plotting calibration for benefit of a prediction model</i>
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Description

This function produces a plot to illustrate the calibration for benefit for a prediction model. The samples are split into a number of groups according to their predicted benefit, and within each group the function estimates the observed treatment benefit and compares it with the predicted one

Usage

```
bencalibr(
  data = NULL,
  Nggroups = 5,
  y.observed,
  treat,
  predicted.treat.0,
  predicted.treat.1,
  type = "continuous",
  smoothing.function = "lm",
  axis.limits = NULL
)
```

Arguments

data	An optional data frame containing the required information.
Nggroups	The number of groups to split the data.
y.observed	The observed outcome.
treat	A vector with the treatment assignment. This must be 0 (for control treatment) or 1 (for active treatment).
predicted.treat.0	A vector with the model predictions for each patient, under the control treatment. For the case of a binary outcome this should be probabilities of an event.
predicted.treat.1	A vector with the model predictions for each patient, under the active treatment. For the case of a binary outcome this should be probabilities of an event.
type	The type of the outcome, "binary" or "continuous".

smoothing.function

The method used to smooth the calibration line. Can be "lm", "glm", "gam", "loess", "rlm". More details can be found in https://ggplot2.tidyverse.org/reference/geom_smooth.html.

axis.limits

Sets the limits of the graph. It can be a vector of two values, i.e. the lower and upper limits for x and y axis. It can be omitted.

Value

The calibration plot

Examples

```
# continuous outcome
dat1=simcont(200)$dat
head(dat1)
lm1=lm(y.observed~(x1+x2+x3)*t, data=dat1)
dat.t0=dat1; dat.t0$t=0
dat.t1=dat1; dat.t1$t=1
dat1$predict.treat.1=predict(lm1, newdata = dat.t1) # predictions in treatment
dat1$predict.treat.0=predict(lm1, newdata = dat.t0) # predicions in control
bencalibr(data=dat1, Ngroups=10, y.observed, predicted.treat.1=predict.treat.1,
          predicted.treat.0=predict.treat.0, type="continuous", treat=t,
          smoothing.function = "lm", axis.limits = c(-1, 1.3))

# binary outcome
dat2=simbinary(500)$dat
head(dat2)
glm1=glm(y.observed~(x1+x2+x3)*t, data=dat2, family = binomial(link = "logit"))
dat2.t0=dat2; dat2.t0$t=0
dat2.t1=dat2; dat2.t1$t=1
dat2$predict.treat.1=predict(glm1, newdata = dat2.t1) # predictions in treatment
dat2$predict.treat.0=predict(glm1, newdata = dat2.t0) # predicions in control
bencalibr(data=dat2, Ngroups=6, y.observed, predicted.treat.1=expit(predict.treat.1),
          predicted.treat.0=expit(predict.treat.0), type="binary", treat=t,
          smoothing.function = "lm")
```

datbinary

Simulated dataset, binary outcome

Description

Simulated dataset, binary outcome

Usage

```
data(datbinary)
```

Format

An object of class `data.frame` with 1000 rows and 13 columns.

Examples

```
data(datbinary)
head(datbinary)
```

datcont	<i>Simulated dataset, continuous outcome</i>
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Description

Simulated dataset, continuous outcome

Usage

```
data(datcont)
```

Format

An object of class `data.frame` with 500 rows and 11 columns.

Examples

```
data(datcont)
head(datcont)
```

expit	<i>Expit</i>
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Description

Calculates the expit of a real number

Usage

```
expit(x)
```

Arguments

x A real number

Value

$\exp(x)/(1+\exp(x))$

Examples

```
expit(2.3)
```

`logit`*Logit*

Description

Calculates the logit of a real number between 0 and 1

Usage

```
logit(x)
```

Arguments

`x` A real number between 0 and 1

Value

```
log(x/(1-x))
```

Examples

```
logit(0.2)
```

`predieval`*Calculating measures for calibration for benefit for a prediction model*

Description

This function calculates a series of measures to assess decision accuracy, discrimination for benefit, and calibration for benefit of a prediction model.

Usage

```
predieval(  
  repeats = 50,  
  Nggroups = 10,  
  X,  
  treat,  
  Y,  
  predicted.treat.1,  
  predicted.treat.0,  
  type = "continuous",  
  bootstraps = 500  
)
```

Arguments

repeats	The number of repetitions for the algorithm.
Nggroups	The number of groups to split the data.
X	A dataframe with patient covariates.
treat	A vector with the treatment assignment. This must be 0 (for control treatment) or 1 (for active treatment).
Y	The observed outcome. For binary outcomes this should be 0 or 1
predicted.treat.1	A vector with the model predictions for each patient, under the active treatment. For the case of a binary outcome this should be probabilities of an event.
predicted.treat.0	A vector with the model predictions for each patient, under the control treatment. For the case of a binary outcome this should be probabilities of an event.
type	The type of the outcome, "binary" or "continuous".
bootstraps	The number of bootstrap samples to be used for calculating confidence intervals.

Value

A table with all estimated measures of performance.

Examples

```
# continuous outcome
dat0=simcont(500)$dat
head(dat0)
# Randomly shuffle the data
dat<-dat0[sample(nrow(dat0)),]
# Create random folds
dat$folds <- cut(seq(1,nrow(dat)),breaks=10,labels=FALSE)

# Obtain out-of-sample predictions
dat.out.CV<-list()
for (i in 1:10){
  dat.in.CV=dat[dat$folds!=i,]
  dat.out.CV[[i]]=dat[dat$folds==i,]
  dat1<-dat.out.CV[[i]]; dat1$t=1
  dat0<-dat.out.CV[[i]]; dat0$t=0
  m1=lm(data=dat.in.CV, y.observed~x1*t+x2*t)
  dat.out.CV[[i]]$predict.treat.1=predict(newdata=dat1, m1)# predictions in treatment
  dat.out.CV[[i]]$predict.treat.0=predict(newdata=dat0, m1)# predicions in control
}

dat.CV=dat.out.CV[[1]]
for (i in 2:10){ dat.CV=rbind(dat.CV,dat.out.CV[[i]])}

# assess model performance
predieval(repeats=20, Nggroups=c(5:10),
          X=dat.CV[,c("x1", "x2", "x3")],
```

```

Y=dat.CV$y.observed,
predicted.treat.1 = dat.CV$predict.treat.1,
predicted.treat.0 = dat.CV$predict.treat.0,
treat=dat.CV$t, type="continuous")

# binary outcome
dat0=simbinary(500)$dat
head(dat0)

# Randomly shuffle the data
dat<-dat0[sample(nrow(dat0)),]
# Create random folds
dat$folds <- cut(seq(1,nrow(dat)),breaks=10,labels=FALSE)

dat.out.CV<-list()
for (i in 1:10){
  dat.in.CV=dat[dat$folds!=i,]
  dat.out.CV[[i]]=dat[dat$folds==i,]
  dat1<-dat.out.CV[[i]]; dat1$t=1
  dat0<-dat.out.CV[[i]]; dat0$t=0
  glm1=glm(y.observed~(x1+x2+x3)*t, data=dat.in.CV, family = binomial(link = "logit"))
  dat.out.CV[[i]]$predict.treat.1=predict(newdata=dat1, glm1)# predictions in treatment
  dat.out.CV[[i]]$predict.treat.0=predict(newdata=dat0, glm1)# predicions in control
}

dat.CV=dat.out.CV[[1]]
for (i in 2:10){ dat.CV=rbind(dat.CV,dat.out.CV[[i]])}

predieval(repeats=20, Ngroups=c(5:10), X=dat.CV[,c("x1", "x2","x3")],
  Y=dat.CV$y.observed,
  predicted.treat.1 = expit(dat.CV$predict.treat.1),
  predicted.treat.0 = expit(dat.CV$predict.treat.0),
  treat=dat.CV$t, type="binary",bootstraps = 50)

```

simbinary

Simulate data for a binary outcome

Description

This function generates a dataframe with 6 patient covariates and a binary outcome simulated from a model that uses the covariates.

Usage

```
simbinary(Npat = 100)
```

Arguments

Npat Number of patients to simulate.

Value

The function returns a dataframe with:

x1, x2, x3, x4, x5, x6= patient covariates.

t= treatment assignment (0 for control, 1 for active).

logit.control= the logit of the probability of an outcome in the control treatment.

logit.active= the logit of the probability of an outcome in the active treatment.

benefit= treatment benefit in log odds ratio.

py=the probability of the outcome for each patient, under the treatment actually administered.

logit.py= the logit of py.

y.observed= the observed outcome

Examples

```
dat1=simbinary(100)$dat
head(dat1)
```

simcont

Simulate data for a prediction model of a continuous outcome

Description

This function generates a dataframe with 6 patient covariates and a continuous outcome simulated from a model that uses the covariates.

Usage

```
simcont(Npat = 100)
```

Arguments

Npat Number of patients to simulate.

Value

The function returns a dataframe with:

x1, x2, x3, x4, x5, x6= patient covariates.

t= treatment assignment (0 for control, 1 for active).

y.control= the outcome if the patient takes the control treatment.

y.active= the outcome if the patient takes the active treatment.

benefit= the treatment benefit, i.e. y.active-y.control.

y.observed= the observed outcome.

Examples

```
dat1=simcont(100)$dat  
head(dat1)
```

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