Package 'otrKM'

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Type Package

Title Optimal Treatment Regimes in Survival Contexts with Kaplan-Meier-Like Estimators

Version 0.1.0

Description Provide methods for estimating optimal treatment regimes in survival contexts with Kaplan-Meier-like estimators when no unmeasured confounding assumption is satisfied (Jiang, R., Lu, W., Song, R., and Davidian, M. (2017) <doi:10.1111/rssb.12201>) and when no unmeasured confounding assumption fails to hold and a binary instrument is available (Xia, J., Zhan, Z., Zhang, J. (2022) <arXiv:2210.05538>).

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R topics documented:

`AIPS` *The (S)AIPS estimator.*

Description

Given a predetermined t0 and eta, calculate t0-year potential survival probability based on the (S)AIPS estimator.

Usage

```
AIPS(eta, datalist, ps, prep, t0, smooth = TRUE)
```

Arguments

`eta`	The parameters of the regime.
`datalist`	A list used to calculate the (S)AIPS estimator including treatment named `a`, observed time named `obs.t`, censoring indicator (0, censored) named `delta`, and baseline covariates used to assign treatment named `1`.
`ps`	A list including the probability of receiving treatment given baseline covariates named `fal`. `Fps.AIPS` can produce `ps` by positing logistic model.
`prep`	A list including the augmented terms in the numerator with treatment all to 1 named `gamma.num.1` and all to 0 named `gamma.num.0` and in the denominator with treatment all to 1 named `gamma.den.1` and all to 0 named `gamma.den.0`; `gamma.num.1` and the others are matrix with ordered observed time as rows and patients as columns. `Fprep.AIPS` can produce `prep` by positing Cox proportional hazards model.
`t0`	A predetermined time.
`smooth`	A logic variable indicating wether a smoothed estimator should be used.

Details

More details can be found in references.

Value

Estimated potential survival probability given eta and t0.

References

Jiang, R., Lu, W., Song, R., and Davidian, M. (2017) On estimation of optimal treatment regimes for maximizing t-year survival probability. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **79:** 1165-1185. DOI:10.1111/rssb.12201

Examples

```
# load data
data(simulation)

# convert the data into a datalist
datalist=list(z=simulation$Instrument,a=simulation$Treatment,
              obs.t=simulation$Survival,delta=simulation$Status,
              l=cbind(simulation$Covariate1,simulation$Covariate2))

# predetermined t0 and eta
t0=5
eta=c(1,2,3)

# calculate ps and prep
ps=Fps.AIPS(datalist)
prep=Fprep.AIPS(datalist, t0)

AIPS(eta, datalist, ps, prep, t0, smooth=TRUE)
```

---

clipp *clip function.*

Description

Limit the number not to be too large or too small.

Usage

```
clipp(x)
```

Arguments

x	A vector or matrix.

Value

A vector or matrix same as the input.

`Fprep.AIPS` *Cox proportional hazards model for eta-free terms in the (S)AIPS estimator.*

Description

Cox proportional hazards model for eta-free terms in the (S)AIPS estimator.

Usage

```
Fprep.AIPS(datalist, t0)
```

Arguments

`datalist`	A list used to calculate the (S)AIPS estimator including treatment named `a`, observed time named `obs.t`, censoring indicator (0, censored) named `delta`, and baseline covariates used to assign treatment named `l`.
`t0`	A predetermined t.

Details

More details can be found in references, `AIPS`, and `Genetic.optim.AIPS`.

Value

A list including the augmented terms in the numerator with treatment all to 1 named `gamma.num.1` and all to 0 named `gamma.num.0` and in the denominator with treatment all to 1 named `gamma.den.1` and all to 0 named `gamma.den.0`; `gamma.num.1` and the others are matrix with ordered observed time as rows and patients as columns. More details can be found in references.

References

Jiang, R., Lu, W., Song, R., and Davidian, M. (2017) On estimation of optimal treatment regimes for maximizing t-year survival probability. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **79:** 1165-1185. DOI:10.1111/rssb.12201

`Fprep.IVEDR` *Cox proportional hazards model for eta-free terms in the (S)IVE-DR estimator.*

Description

Cox proportional hazards model for eta-free terms in the (S)IVE-DR estimator.

Usage

```
Fprep.IVEDR(datalist, ps, t0)
```

Arguments

datalist	A list used to calculate the (S)IVE-DR estimator including treatment named a, observed time named obs.t, censoring indicator (0, censored) named delta, and baseline covariates used to assign treatment named l.
ps	A list including the probability of receiving instrument given baseline covariates named fzl, the probability of receiving treatment given baseline covariates and instrument equaling 0 named fal0, the probability of receiving treatment given baseline covariates and instrument equaling 1 named fal1, and the difference between fal1 and fal0 named deltal. Fps.IVEDR can produce ps by positing logistic model.
t0	A predetermined t.

Details

More details can be found in references, IVEDR, and Genetic.optim.IVEDR.

Value

A list including estimates $\hat{\gamma}_1(\boldsymbol{L}; s)$ with treatment all to 1 named gamma.num.1 and all to 0 named gamma.num.0, $\hat{\gamma}_1'(\boldsymbol{L}; s)$ with treatment all to 1 named gammaa.num.1 and all to 0 named gammaa.num.0, $\hat{\gamma}_2(\boldsymbol{L}; s)$ with treatment all to 1 named gamma.den.1 and all to 0 named gamma.den.0, and $\hat{\gamma}_2'(\boldsymbol{L}; s)$ with treatment all to 1 named gammaa.den.1 and all to 0 named gammaa.den.0; gamma.num.1 and the others are matrix with ordered observed time as rows and patients as columns. More details can be found in references.

References

Xia, J., Zhan, Z., Zhang, J. (2022) An anti-confounding method for estimating optimal regime in a survival context using instrumental variable. Under Review.

Fps.AIPS — *Logistic regression for observed treatment used for the (S)AIPS estimator.*

Description

Logistic regression for observed treatment used for the (S)AIPS estimator.

Usage

```
Fps.AIPS(datalist)
```

Arguments

datalist	A list used to calculate the (S)AIPS estimator including treatment named a, observed time named obs.t, censoring indicator (0, censored) named delta, and baseline covariates used to assign treatment named l.

Details

More details can be found in references, AIPS, and Genetic.optim.AIPS.

Value

A list including the probability of receiving treatment given baseline covariates named fal.

References

Jiang, R., Lu, W., Song, R., and Davidian, M. (2017) On estimation of optimal treatment regimes for maximizing t-year survival probability. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **79:** 1165-1185. DOI:10.1111/rssb.12201

Fps.IPS *Logistic regression for observed treatment used for the (S)IPS estimator.*

Description

Logistic regression for observed treatment used for the (S)IPS estimator.

Usage

```
Fps.IPS(datalist)
```

Arguments

datalist	A list used to calculate the (S)IPS estimator including treatment named a, observed time named obs.t, censoring indicator (0, censored) named delta, and baseline covariates used to assign treatment named l.

Details

More details can be found in references, IPS, and Genetic.optim.IPS.

Value

A list including the probability of receiving treatment given baseline covariates named fal.

References

Jiang, R., Lu, W., Song, R., and Davidian, M. (2017) On estimation of optimal treatment regimes for maximizing t-year survival probability. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **79:** 1165-1185. DOI:10.1111/rssb.12201

`Fps.IVE` *Logistic regression for observed treatment and instrument used for the (S)IVE estimator.*

Description

Logistic regression for observed treatment and instrument used for the (S)IVE estimator.

Usage

```
Fps.IVE(datalist)
```

Arguments

`datalist`	A list used to calculate the (S)IVE estimator including treatment named `a`, observed time named `obs.t`, censoring indicator (0, censored) named `delta`, and baseline covariates used to assign treatment named `l`.

Details

More details can be found in references, `IVE`, and `Genetic.optim.IVE`.

Value

A list including the probability of receiving instrument given baseline covariates named `fzl` and the difference between fal1 and fal0 named `deltal`, where fal0 denotes the probability of receiving treatment given baseline covariates and instrument equaling 0, and fal1 denotes the probability of receiving treatment given baseline covariates and instrument equaling 1.

References

Xia, J., Zhan, Z., Zhang, J. (2022) An anti-confounding method for estimating optimal regime in a survival context using instrumental variable. Under Review.

`Fps.IVEDR` *Logistic regression for observed treatment and instrument used for the (S)IVE-DR estimator.*

Description

Logistic regression for observed treatment and instrument used for the (S)IVE-DR estimator.

Usage

```
Fps.IVEDR(datalist)
```

Arguments

datalist	A list used to calculate the (S)IVE-DR estimator including treatment named a, observed time named obs.t, censoring indicator (0, censored) named delta, and baseline covariates used to assign treatment named l.

Details

More details can be found in references, IVEDR, and Genetic.optim.IVEDR.

Value

A list including the probability of receiving instrument given baseline covariates named fzl, the probability of receiving treatment given baseline covariates and instrument equaling 0 named fal0, the probability of receiving treatment given baseline covariates and instrument equaling 1 named fal1, and the difference between fal1 and fal0 named deltal.

References

Xia, J., Zhan, Z., Zhang, J. (2022) An anti-confounding method for estimating optimal regime in a survival context using instrumental variable. Under Review.

Genetic.optim.AIPS *The optimal treatment regime based on the (S)AIPS estimator.*

Description

Given a predetermined t0, estimate the optimal treatment regime by maximizing t0-year survival probability based on the (S)AIPS estimator.

Usage

```
Genetic.optim.AIPS(datalist, ps, prep, t0, smooth = TRUE)
```

Arguments

datalist	A list used to calculate the (S)AIPS estimator including treatment named a, observed time named obs.t, censoring indicator (0, censored) named delta, and baseline covariates used to assign treatment named l.
ps	A list including the probability of receiving treatment given baseline covariates named fal. Fps.AIPS can produce ps by positing logistic model.
prep	A list including the augmented terms in the numerator with treatment all to 1 named gamma.num.1 and all to 0 named gamma.num.0 and in the denominator with treatment all to 1 named gamma.den.1 and all to 0 named gamma.den.0; gamma.num.1 and the others are matrix with ordered observed time as rows and patients as columns. Fprep.AIPS can produce prep by positing Cox proportional hazards model.
t0	A predetermined time.
smooth	A logic variable indicating wether a smoothed version should be used.

Details

More details can be found in references.

Value

A numeric vector in which the last number is the estimated optimal t0-year survival probability and others are the estimated parameters of the optimal treatment regime.

References

Jiang, R., Lu, W., Song, R., and Davidian, M. (2017) On estimation of optimal treatment regimes for maximizing t-year survival probability. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **79:** 1165-1185. DOI:10.1111/rssb.12201

Examples

```
# load data
data(simulation)

# convert the data into a datalist
datalist=list(z=simulation$Instrument,a=simulation$Treatment,
              obs.t=simulation$Survival,delta=simulation$Status,
              l=cbind(simulation$Covariate1,simulation$Covariate2))

# predetermined t0
t0=5

# calculate ps and prep
ps=Fps.AIPS(datalist)
prep=Fprep.AIPS(datalist, t0)

Genetic.optim.AIPS(datalist, ps, prep, t0, smooth=TRUE)
```

`Genetic.optim.IPS` *The optimal treatment regime based on the (S)IPS estimator.*

Description

Given a predetermined t0, estimate the optimal treatment regime by maximizing t0-year survival probability based on the (S)IPS estimator.

Usage

```
Genetic.optim.IPS(datalist, ps, t0, smooth = TRUE)
```

Arguments

datalist	A list used to calculate the (S)IPS estimator including treatment named a, observed time named obs.t, censoring indicator (0, censored) named delta, and baseline covariates used to assign treatment named l.
ps	A list including the probability of receiving treatment given baseline covariates named fal. Fps.IPS can produce ps by positing logistic model.
t0	A predetermined time.
smooth	A logic variable indicating wether a smoothed version should be used.

Details

More details can be found in references.

Value

A numeric vector in which the last number is the estimated optimal t0-year survival probability and the others are the estimated parameter of the optimal treatment regime.

References

Jiang, R., Lu, W., Song, R., and Davidian, M. (2017) On estimation of optimal treatment regimes for maximizing t-year survival probability. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **79:** 1165-1185. DOI:10.1111/rssb.12201

Examples

```
# load data
data(simulation)

# convert the data into a datalist
datalist=list(z=simulation$Instrument,a=simulation$Treatment,
              obs.t=simulation$Survival,delta=simulation$Status,
              l=cbind(simulation$Covariate1,simulation$Covariate2))

# predetermined t0
t0=5

# calculate ps
ps=Fps.IPS(datalist)

Genetic.optim.IPS(datalist, ps, t0, smooth=TRUE)
```

`Genetic.optim.IVE` *The optimal treatment regime based on the (S)IVE estimator.*

Description

Given a predetermined t0, estimate the optimal treatment regime by maximizing t0-year survival probability based on the (S)IVE estimator.

Usage

```
Genetic.optim.IVE(datalist, ps, t0, smooth = TRUE)
```

Arguments

`datalist`	A list used to calculate the (S)IVE estimator including instrument named z, treatment named `a`, observed time named `obs.t`, censoring indicator (0, censored) named `delta`, and baseline covariates used to assign treatment named `l`.
`ps`	A list including the probability of receiving instrument given baseline covariates named `fzl` and the difference between fal1 and fal0 named `deltal`, where fal0 denotes the probability of receiving treatment given baseline covariates and instrument equaling 0, and fal1 denotes the probability of receiving treatment given baseline covariates and instrument equaling 1. `Fps.IVE` can produce `ps` by positing logistic model.
`t0`	A predetermined time.
`smooth`	A logic variable indicating wether a smoothed version should be used.

Details

More details can be found in references.

Value

A numeric vector in which the last number is the estimated optimal t0-year survival probability and others are the estimated parameter of the optimal treatment regime.

References

Xia, J., Zhan, Z., Zhang, J. (2022) An anti-confounding method for estimating optimal regime in a survival context using instrumental variable. Under Review.

Examples

```
# load data
data(simulation)

# convert the data into a datalist
datalist=list(z=simulation$Instrument,a=simulation$Treatment,
```

```
              obs.t=simulation$Survival,delta=simulation$Status,
              l=cbind(simulation$Covariate1,simulation$Covariate2))

# calculate ps and prep
ps=Fps.IVE(datalist)

# predetermined t0
t0=5

Genetic.optim.IVE(datalist, ps, t0, smooth=TRUE)
```

`Genetic.optim.IVEDR` *The optimal treatment regime based on the (S)IVE-DR estimator.*

Description

Given a predetermined t0, estimate the optimal treatment regime by maximizing t0-year survival probability based on the (S)IVE-DR estimator.

Usage

```
Genetic.optim.IVEDR(datalist, ps, prep, t0, smooth = TRUE)
```

Arguments

`datalist`	A list used to calculate the (S)IVE-DR estimator including instrument named `z`, treatment named `a`, observed time named `obs.t`, censoring indicator (0, censored) named `delta`, and baseline covariates used to assign treatment named `l`.
`ps`	A list including the probability of receiving instrument given baseline covariates named `fzl`, the probability of receiving treatment given baseline covariates and instrument equaling 0 named `fal0`, the probability of receiving treatment given baseline covariates and instrument equaling 1 named `fal1`, and the difference between fal1 and fal0 named `deltal`. `Fps.IVEDR` can produce `ps` by positing logistic model.
`prep`	A list including estimates $\hat{\gamma}_1(\boldsymbol{L}; s)$ with treatment all to 1 named `gamma.num.1` and all to 0 named `gamma.num.0`, $\hat{\gamma}_1'(\boldsymbol{L}; s)$ with treatment all to 1 named `gammaa.num.1` and all to 0 named `gammaa.num.0`, $\hat{\gamma}_2(\boldsymbol{L}; s)$ with treatment all to 1 named `gamma.den.1` and all to 0 named `gamma.den.0`, and $\hat{\gamma}_2'(\boldsymbol{L}; s)$ with treatment all to 1 named `gammaa.den.1` and all to 0 named `gammaa.den.0`; `gamma.num.1` and the others are matrix with ordered observed time as rows and patients as columns. More details can be found in references. `Fprep.IVEDR` can produce `prep` by positing Cox proportional hazards model.
`t0`	A predetermined time to point out that t0-year survival probability is our estimate
`smooth`	A logic variable indicating wether a smoothed version should be used.

Details

More details can be found in references.

Value

A numeric vector in which the last number is the estimated optimal t0-year survival probability and the others are the estimated parameter of the optimal treatment regime.

References

Xia, J., Zhan, Z., Zhang, J. (2022) An anti-confounding method for estimating optimal regime in a survival context using instrumental variable. Under Review.

Examples

```
# load data
data(simulation)

# convert the data into a datalist
datalist=list(z=simulation$Instrument,a=simulation$Treatment,
              obs.t=simulation$Survival,delta=simulation$Status,
              l=cbind(simulation$Covariate1,simulation$Covariate2))

#' # predetermined t0
t0=1

# calculate ps and prep
ps=Fps.IVEDR(datalist)
prep=Fprep.IVEDR(datalist, ps, t0)


Genetic.optim.IVEDR(datalist, ps, prep, t0, smooth=TRUE)
```

IPS *The (S)IPS estimator.*

Description

Given a predetermined t0 and eta, calculate t0-year potential survival probability based on the (S)IPS estimator.

Usage

```
IPS(eta, datalist, ps, t0, smooth = TRUE)
```

Arguments

eta	The parameters of the regime.
datalist	A list used to calculate the (S)IPS estimator including treatment named a, observed time named obs.t, censoring indicator (0, censored) named delta, and baseline covariates used to assign treatment named l. Fps.IPS can produce ps by positing logistic model.
ps	A list including the probability of receiving treatment given baseline covariates named fal.
t0	A predetermined time.
smooth	A logic variable indicating wether a smoothed estimator should be used.

Details

More details can be found in references.

Value

Estimated potential survival probability given eta and t0.

References

Jiang, R., Lu, W., Song, R., and Davidian, M. (2017) On estimation of optimal treatment regimes for maximizing t-year survival probability. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, **79:** 1165-1185. DOI:10.1111/rssb.12201

Examples

```
# load data
data(simulation)

# convert the data into a datalist
datalist=list(z=simulation$Instrument,a=simulation$Treatment,
              obs.t=simulation$Survival,delta=simulation$Status,
              l=cbind(simulation$Covariate1,simulation$Covariate2))

# calculate ps
ps=Fps.IPS(datalist)

# predetermined t0 and eta
t0=5
eta=c(1,2,3)

IPS(eta, datalist, ps, t0, smooth=TRUE)
```

IVE *The (S)IVE estimator.*

Description

Given a predetermined t0 and eta, calculate t0-year potential survival probability based on the (S)IVE estimator.

Usage

```
IVE(eta, datalist, ps, t0, smooth = TRUE)
```

Arguments

eta	The parameters of the regime.
datalist	A list used to calculate the (S)IVE estimator including treatment named a, observed time named obs.t, censoring indicator (0, censored) named delta, and baseline covariates used to assign treatment named l.
ps	A list including the probability of receiving instrument given baseline covariates named fzl and the difference between fal1 and fal0 named deltal, where fal0 denotes the probability of receiving treatment given baseline covariates and instrument equaling 0, and fal1 denotes the probability of receiving treatment given baseline covariates and instrument equaling 1. Fps.IVE can produce ps by positing logistic model.
t0	A predetermined time.
smooth	A logic variable indicating wether a smoothed version should be used.

Details

More details can be found in references.

Value

Estimated potential survival probability given eta and t0.

References

Xia, J., Zhan, Z., Zhang, J. (2022) An anti-confounding method for estimating optimal regime in a survival context using instrumental variable. Under Review.

Examples

```
# load data
data(simulation)

# convert the data into a datalist
datalist=list(z=simulation$Instrument,a=simulation$Treatment,
```

```
              obs.t=simulation$Survival,delta=simulation$Status,
              l=cbind(simulation$Covariate1,simulation$Covariate2))

# calculate ps and prep
ps=Fps.IVE(datalist)

# predetermined eta
t0=5
eta=c(1,2,3)

IVE(eta, datalist, ps, t0, smooth=TRUE)
```

IVEDR *The (S)IVE-DR estimator.*

Description

Given a predetermined t0 and eta, calculate t0-year potential survival probability based on the (S)IVE-DR estimator.

Usage

```
IVEDR(eta, datalist, ps, prep, t0, smooth = TRUE)
```

Arguments

eta	The parameters of the regime.
datalist	A list used to calculate the (S)IVE-DR estimator including treatment named a, observed time named obs.t, censoring indicator (0, censored) named delta, and baseline covariates used to assign treatment named l.
ps	A list including the probability of receiving instrument given baseline covariates named fzl, the probability of receiving treatment given baseline covariates and instrument equaling 0 named fal0, the probability of receiving treatment given baseline covariates and instrument equaling 1 named fal1, and the difference between fal1 and fal0 named deltal. Fps.IVEDR can produce ps by positing logistic model.
prep	A list including estimates $\hat{\gamma}_1(\boldsymbol{L}; s)$ with treatment all to 1 named gamma.num.1 and all to 0 named gamma.num.0, $\hat{\gamma}'_1(\boldsymbol{L}; s)$ with treatment all to 1 named gammaa.num.1 and all to 0 named gammaa.num.0, $\hat{\gamma}_2(\boldsymbol{L}; s)$ with treatment all to 1 named gamma.den.1 and all to 0 named gamma.den.0, and $\hat{\gamma}'_2(\boldsymbol{L}; s)$ with treatment all to 1 named gammaa.den.1 and all to 0 named gammaa.den.0; gamma.num.1 and the others are matrix with ordered observed time as rows and patients as columns. More details can be found in references. Fprep.IVEDR can produce prep by positing Cox proportional hazards model.
t0	A predetermined time.
smooth	A logic variable indicating wether a smoothed version should be used.

Details

More details can be found in references.

Value

Estimated potential survival probability given eta and t0.

References

Xia, J., Zhan, Z., Zhang, J. (2022) An anti-confounding method for estimating optimal regime in a survival context using instrumental variable. Under Review.

Examples

```
# load data
data(simulation)

# convert the data into a datalist
datalist=list(z=simulation$Instrument,a=simulation$Treatment,
              obs.t=simulation$Survival,delta=simulation$Status,
              l=cbind(simulation$Covariate1,simulation$Covariate2))

#' # predetermined t0 and eta
t0=5
eta=c(1,2,3)

# calculate ps and prep
ps=Fps.IVEDR(datalist)
prep=Fprep.IVEDR(datalist, ps, t0)

IVEDR(eta, datalist, ps, prep, t0, smooth=TRUE)
```

`simulation` *Simulation*

Description

A simulation data to help understand and implement the functions in the package. 'Instrument' denotes the binary instrumental variable. 'Treatment' denotes the binary treatment. 'Survival' denotes the observed survival time. 'Status' denotes whether the the data is censoring where '0' means censoring. 'Covariate' denotes the baseline characteristics.

Usage

```
simulation
```

Format

An object of class `data.frame` with 500 rows and 6 columns.

Examples

```
head(simulation)
```

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