

# Package ‘survSens’

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**Type** Package

**Title** Sensitivity Analysis with Time-to-Event Outcomes

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**Description** Performs a dual-parameter sensitivity analysis of treatment effect to unmeasured confounding in observational studies with either survival or competing risks outcomes. Huang, R., Xu, R. and Dulai, P.S.(2019) <arXiv:1908.01444>.

**License** GPL-2

**Encoding** UTF-8

**LazyData** true

**Depends** R (>= 3.4.0)

**Imports** survival, ggplot2, directlabels

**NeedsCompilation** no

**URL** <https://github.com/Rong0707/survSens>

**Repository** CRAN

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comprdata	<i>An example dataset with competing risks outcomes.</i>
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**Description**

An example dataset with competing risks outcomes that can be used for comprSensitivity.

**Usage**

```
data("comprdata")
```

**Format**

The format is a list of 5, corresponding to t, d, Z, X, U, respectively.

**References**

Huang, R., Xu, R., & Dulai, P. S. (2019). Sensitivity Analysis of Treatment Effect to Unmeasured Confounding in Observational Studies with Survival and Competing Risks Outcomes. arXiv preprint arXiv:1908.01444.

**Examples**

```
data(comprdata)
```

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comprSensitivity	<i>Sensitivity analysis of treatment effect to unmeasured confounding with competing risks outcomes.</i>
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**Description**

comprSensitivity performs a dual-parameter sensitivity analysis of treatment effect to unmeasured confounding in observational studies with competing risks outcomes.

**Usage**

```
comprSensitivity(t, d, Z, X, method, zetaT = seq(-2,2,by=0.5),  
zetaT2 = 0, zetaZ = seq(-2,2,by=0.5), theta = 0.5, B = 50, Bem = 200)
```

**Arguments**

t	survival outcomes with competing risks.
d	indicator of occurrence of event, with $d = 0$ denotes right censoring, $d = 1$ denotes event of interest, $d = 2$ denotes competing risk.
Z	indicator of treatment.
X	pre-treatment covariates that will be included in the model as measured confounders.
method	needs to be one of "stoEM_reg", "stoEM_IPW" and "EM_reg".
zetaT	range of coefficient of $U$ in the event of interest response model.
zetaT2	value of coefficient of $U$ in the competing risk response model
zetaZ	range of coefficient of $U$ in the treatment model.
theta	marginal probability of $U = 1$ .
B	iteration in the stochastic EM algorithm.
Bem	iteration used to estimate the variance-covariance matrix in the EM algorithm.

**Details**

This function performs a dual-parameter sensitivity analysis of treatment effect to unmeasured confounding by either drawing simulated potential confounders  $U$  from the conditional distribution of  $U$  given observed response, treatment and covariates or the Expectation-Maximization algorithm. We assume  $U$  is following *Bernoulli*( $\pi$ ) (default 0.5). Given  $Z$ ,  $X$  and  $U$ , the hazard rate of the  $j$ th type of failure is modeled using the Cox proportional hazards (PH) regression:

$$\lambda_j(t|Z, X, U) = \lambda_{j0}(t) \exp(\tau_j Z + X' \beta_j + \zeta_j U).$$

Given  $X$  and  $U$ ,  $Z$  follows a generalized linear model:

$$P(Z = 1|X, U) = \Phi(X' \beta_z + \zeta_z U).$$

**Value**

tau1	a data.frame with zetaz, zetaT1, zetaT2, tau1, tau1.se and t statistic in the event of interest response model.
tau2	a data.frame with zetaz, zetaT, zetaT2, tau2, tau2.se and t statistic in the competing risks response model.

**Author(s)**

Rong Huang

**References**

Huang, R., Xu, R., & Dulai, P. S. (2019). Sensitivity Analysis of Treatment Effect to Unmeasured Confounding in Observational Studies with Survival and Competing Risks Outcomes. arXiv preprint arXiv:1908.01444.

**Examples**

```
#load the dataset included in the package
data(comprdata)
#stochastic EM with regression
tau.sto = comprSensitivity(comprdata$t, comprdata$d, comprdata$Z, comprdata$X,
"stoEM_reg", zetaT = 0.5, zetaZ = 0.5, B = 3)

#EM with regression
tau.em = comprSensitivity(comprdata$t, comprdata$d, comprdata$Z, comprdata$X,
"EM_reg", zetaT = 0.5, zetaZ = 0.5, Bem = 50)
```

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plotsens

*A contour plot of sensitivity analysis results.*


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**Description**

A contour plot of sensitivity analysis results.

**Usage**

```
plotsens(tau.res, zetaz, zetat, tau1, coeff0)
```

**Arguments**

tau.res	a data.frame that can be generated from either survSensitivity or comprSensitivity.
zetaz	the name of sensitivity parameter in the treatment model.
zetat	the name of sensitivity parameter in the response model.
tau1	the name of estimated treatment effect.
coeff0	the value of estimated treatment effect ignoring any confounding.

**Details**

This function gives a contour plot in order to visualize results from either survSensitivity or comprSensitivity.

**Value**

A contour plot corresponding to the output from either survSensitivity or comprSensitivity.

**Author(s)**

Rong Huang

**Examples**

```
data(tau.res) #an example output
plotsens(tau.res, "zetaz", "zetat", "tau1", coeff0 = 1.131)
```

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survdata	<i>An example dataset with survival outcomes.</i>
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**Description**

An example dataset with survival outcomes that can be used for survSensitivity.

**Usage**

```
data("survdata")
```

**Format**

The format is a list of 5, corresponding to t, d, Z, X, U, respectively.

**References**

Huang, R., Xu, R., & Dulai, P. S. (2019). Sensitivity Analysis of Treatment Effect to Unmeasured Confounding in Observational Studies with Survival and Competing Risks Outcomes. arXiv preprint arXiv:1908.01444.

**Examples**

```
data(survdata)
```

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survSensitivity	<i>Sensitivity analysis of treatment effect to unmeasured confounding with survival outcomes.</i>
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**Description**

survSensitivity performs a dual-parameter sensitivity analysis of treatment effect to unmeasured confounding in observational studies with survival outcomes.

**Usage**

```
survSensitivity(t, d, Z, X, method, zetaT = seq(-2,2,by=0.5),  
zetaZ = seq(-2,2,by=0.5), theta = 0.5, B = 50, Bem = 200)
```

**Arguments**

t	survival outcomes.
d	indicator of occurrence of event, with $d == 0$ denotes right censoring.
Z	indicator of treatment.
X	pre-treatment covariates that will be included in the model as measured confounders.
method	needs to be one of "stoEM_reg", "stoEM_IPW", and "EM_reg".
zetaT	range of coefficient of $U$ in the response model.
zetaZ	range of coefficient of $U$ in the treatment model.
theta	marginal probability of $U = 1$ .
B	iteration in the stochastic EM algorithm.
Bem	iteration used to estimate the variance-covariance matrix in the EM algorithm.

**Details**

This function performs a dual-parameter sensitivity analysis of treatment effect to unmeasured confounding by either drawing simulated potential confounders  $U$  from the conditional distribution of  $U$  given observed response, treatment and covariates or the Expectation-Maximization algorithm. We assume  $U$  is following *Bernoulli*( $\pi$ ) (default 0.5). Given  $Z$ ,  $X$  and  $U$ , the hazard rate is modeled using the Cox proportional hazards (PH) regression:

$$\lambda(t|Z, X, U) = \lambda_0(t) \exp(\tau Z + X' \beta + \zeta U).$$

Given  $X$  and  $U$ ,  $Z$  follows a generalized linear model:

$$P(Z = 1|X, U) = \Phi(X' \beta_z + \zeta_z U).$$

**Value**

tau	a data.frame with zetaz, zetat, tau1, tau1.se and t statistic.
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**Author(s)**

Rong Huang

**References**

Huang, R., Xu, R., & Dulai, P. S. (2019). Sensitivity Analysis of Treatment Effect to Unmeasured Confounding in Observational Studies with Survival and Competing Risks Outcomes. arXiv preprint arXiv:1908.01444.

**Examples**

```
#load the dataset included in the package.
data(survdata)
#stochastic EM with regression
tau.sto = survSensitivity(survdata$t, survdata$d, survdata$Z, survdata$X,
"stoEM_reg", zetaT = 0.5, zetaZ = 0.5, B = 3)

#EM with regression
tau.em = survSensitivity(survdata$t, survdata$d, survdata$Z, survdata$X,
"EM_reg", zetaT = 0.5, zetaZ = 0.5, Bem = 50)
```

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tau.res

*Sensitivity analysis output example*

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**Description**

An example output from survSensitivity.

**Usage**

```
data("tau.res")
```

**Format**

A data frame with 81 observations on the following 5 variables.

zetaz a numeric vector, corresponding to the sensitivity parameter in the treatment model.

zetat a numeric vector, corresponding to the sensitivity parameter in the response model.

tau1 a numeric vector, corresponding to the estimated treatment effect.

tau1.se a numeric vector, corresponding to the standard error of the estimated treatment effect.

t a numeric vector, corresponding to the t statistic.

**Examples**

```
data(tau.res)
```

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