

# Package ‘p3state.msm’

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**Title** Analyzing survival data

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## R topics documented:

p3state.msm-package . . . . .	2
Biv . . . . .	2
data.creation.reg . . . . .	3
heart2 . . . . .	3
p3state . . . . .	4
pLIDA . . . . .	6
plot.p3state . . . . .	7
summary.p3state . . . . .	8
<b>Index</b>	<b>10</b>

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p3state.msm-package     *Inference in an Illness-Death Model*

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### Description

p3state.msm provides functions for estimating semi-parametric regression models but also to implement nonparametric estimators for the transition probabilities. The methods can also be used in progressive three-state models.

In progressive three-state models, estimators for other quantities such as the bivariate distribution function (for the sequentially ordered events) are also given

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Biv                             *Bivariate distribution function*

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### Description

Computation of the bivariate distribution function

### Usage

```
Biv(object, time1, time2)
```

### Arguments

object	Component datafr of an object of class p3state.
time1	The first time for obtaining estimates for the transition probabilities, bivariate distribution function. NULL is equivalent to 0.
time2	The second time for obtaining estimates for the bivariate distribution function.

### Author(s)

Luis Meira-Machado and Javier Roca-Pardinas

### See Also

[p3state](#)

### Examples

```
data(heart2)
res.p3state<-p3state(heart2)
Biv(res.p3state,time1=30,time2=300)
```

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data.creation.reg      *Regression Dataset*

---

### Description

Returns the input data in a different format. Provides the adequate dataset for implementing regression models.

### Usage

```
data.creation.reg(data)
```

### Arguments

data	A data.frame with at least 5 variables: times1 (time of the intermediate event/censoring time), delta (indicator of transition to the intermediate event), times2 (time to the final event/censoring time), time (times1 + times2) and status (censoring indicator: "dead"=1,"alive"=0). The remaining variables in the data.frame are left for the covariates.
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### Value

A data.frame in a counting process format.

### Author(s)

Luis Felipe Meira-Machado and Javier Roca-Pardinas

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heart2      *More Stanford Heart Transplant data*

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### Description

This contains the Stanford Heart Transplant data in a different format. The main data set is in ([heart](#)). Survival of patients on the waiting list for the Stanford heart transplant program.

### Usage

```
data(heart2)
```

**Format**

A data frame with 103 observations on the following 8 variables.

times1 time of transplant/censoring time  
 delta transplant indicator  
 times2 time to death since the transplant/censoring time  
 time times1 + times2  
 status censoring indicator: dead=1, alive=0  
 age age-48 years  
 year year of acceptance; in years after 1 Nov 1967  
 surgery prior bypass surgery; 1=yes

**References**

J Crowley and M Hu (1977), Covariance analysis of heart transplant survival data. *Journal of the American Statistical Association*, 72, 27-36.

**See Also**

[heart](#)

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p3state

*Inference in progressive multi-state models with three states*

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**Description**

This function provides nonparametric estimates in progressive multi-state models with three states (illness-death model and three-state model). Fits also semi-parametric Cox models in a multi-state framework (one for each transition).

**Usage**

```
p3state(data, coxdata = NULL, formula = NULL, regression = NULL)
```

**Arguments**

data	The input data. A data.frame in which to interpret the variables named in the covariates. A data frame with at least 5 variables: times1 (time of the intermediate event/censoring time), delta (indicator of transition to the intermediate event), times2 (time to the final event/censoring time), time (times1 + times2) and status (censoring indicator: "dead"=1, "alive"=0). The remaining variables in the data.frame are left for the covariates.
coxdata	Data set in a counting process data-structure. This data set can be obtained using data.creation.reg. If NULL the main function p3state will automatically create this dataset every time it is called.
formula	A formula giving the vector of covariates. For example formula=~age+sex
regression	A logical variable indicating whether you want the regression model.

## Details

Multi-state models may be considered a generalization of survival analysis where survival is the ultimate outcome of interest but where intermediate (transient) states are identified. The influence of the intermediate events on survival may be investigated through the effect of the time-dependent covariate (using the Cox regression model with time-dependent covariates; TDCM). However, these covariates can also be re-expressed as a multi-state model with states based on the values of the covariate (typically coded as 1=yes; 0=no). If all subjects observe the intermediate event then the time-dependent covariate makes it possible to use the progressive three-state model. Otherwise makes it feasible to use an illness-death model. In these models issues, of interest include the estimation of transition probabilities and assessing the effects of individual risk factors.

## Value

Returns a list of the following items:

descriptives	vector with observed transitions between states
datafr	data.frame to be used for obtaining the nonparametric estimates and for plotting purposes
tdcm	coxph object with the fit of the Cox regression model with time-dependent covariates
msm12	coxph object with the fit of the Cox model for transition from state 1 to state 2
msm13	coxph object with the fit of the Cox model for transition from state 1 to state 3 (only for the progressive three-state model)
cmm23	coxph object with the fit of the Cox Markov model for transition from state 2 to state 3
tma	coxph object with the fit of a Cox model for testing the Markov assumption

## Author(s)

Luis Meira-Machado and Javier Roca-Pardinas

## References

- Meira-Machado L, De Una-Alvarez J, Cadarso-Suarez C (2006). "Nonparametric estimation of transition probabilities in a non-Markov illness-death model." *Lifetime Data Analysis*, 12, 325-344.
- de Una-Alvarez J, Meira-Machado LF (2008). A simple estimator of the bivariate distribution function for censored gap times. *Statistics & Probability Letters*, 78: 2440-2445.
- Meira-Machado l, Roca-Pardinas J (2011). "p3state.msm: Analyzing Survival Data from an Illness-Death Model." *Journal of Statistical Software*, 38(3): 1-18.

## Examples

```
data(heart2)
res.p3state<-p3state(heart2, formula=~age+year+surgery)
summary(res.p3state)
##Only regression
summary(res.p3state, model="TDCM")
```

```
summary(res.p3state,model="CMM")
##without regression
summary(res.p3state,time1=20,time2=200)
##Both
summary(res.p3state,estimate=TRUE,time1=20,time2=200,model="CMM")

##Just for illustration purposes we create a new subset by restricting
##the original data set from those subjects experiencing the transplant
## (progressive three-state model)
p<-which((heart2$delta==0 & heart2$status==0) | heart2$delta==1)
exempladata<-heart2[p,]
res2.p3state<-p3state(exempladata)
summary(res2.p3state)
```

---

pLIDA

*Transition probabilities*


---

### Description

Computation of the transition probabilities.

### Usage

```
pLIDA(object, time1, time2,tp=NULL)
```

### Arguments

object	Component datafr of an object of class p3state.
time1	The first time for obtaining estimates for the transition probabilities, bivariate distribution function. NULL is equivalent to 0.
time2	The second time for obtaining estimates for the bivariate distribution function.
tp	Optional argument: tp="all" (default value) to obtain all the transition probabilities p11, p12 and p22; tp="p11" to obtain only p11; tp="p12" to obtain only p12;tp="p22" to obtain only p22.

### See Also

[p3state](#)

### Examples

```
data(heart2)
res.p3state<-p3state(heart2)
pLIDA(res.p3state,time1=30,time2=300)
```

---

plot.p3state                      *Plot Method for an p3state object*

---

### Description

Plot method for an object of class 'p3state'. It draws the estimated transition probabilities, bivariate distribution of the gap times and marginal distribution of the second gap time (the last two only available for the progressive three-state model)

### Usage

```
## S3 method for class 'p3state'
plot(x, plot.trans = NULL, plot.marginal = NULL,
     plot.bivariate = NULL, time1, time2, xlab, ylab, zlab, col, col.biv = NULL, ...)
```

### Arguments

x	an object of class p3state.
plot.trans	Graphical output for the transition probabilities. By default, plot.trans=FALSE. Possible values are: "all", "P11", "P12", "P22" and "P23".
plot.marginal	Graphical output for the marginal distribution of the second time (only available for the progressive three-state model). By default, plot.marginal=FALSE.
plot.bivariate	Graphical output for the bivariate distribution (only available for the progressive three-state model). By default, plot.bivariate=FALSE.
time1	The first time for obtaining estimates for the transition probabilities, bivariate distribution function. NULL is equivalent to 0.
time2	The second time for obtaining estimates for the bivariate distribution function.
xlab	x-axis label.
ylab	y-axis label.
zlab	z-axis label (only for the bivariate distribution).
col	Colour for the bivariate plot.
col.biv	A logical variable indicating whether you want color to be used in the filled.contour plot. By default col.biv = FALSE.
...	Further arguments for plot

### Author(s)

Luis Meira-Machado and Javier Roca-Pardinas

### See Also

[p3state](#)

**Examples**

```

data(heart2)
res.p3state<-p3state(heart2)
##Only transition probabilities
plot(res.p3state,plot.trans="all",time1=20,time2=100)

##Example of three-state model. All plots.
p<-which((heart2$delta==0 & heart2$status==0) | heart2$delta==1)
inputdata<-heart2[p,]
res2.p3state<-p3state(inputdata)
plot(res2.p3state,plot.trans="all",time1=20,
time2=200,plot.bivariate=TRUE,plot.marginal=TRUE)

```

summary.p3state

*Summary Methods for an p3state Object***Description**

Provides results for an object of class p3state. It gives the estimated transition probabilities, bivariate distribution of the gap times and marginal distribution of the second gap time (the last two only available for the progressive three-state model). Provides also the results for the fit of semi-parametric Cox regression models.

**Usage**

```

## S3 method for class 'p3state'
summary(object, model = NULL, covmat = NULL,
estimate = NULL, time1 = NULL, time2 = NULL, ...)

```

**Arguments**

object	an object of class p3state.
model	A character string specifying which model(s) to fit. Possible values are "TDCM", "CMM" and "CSMM". If NULL none of the regression models will be implemented.
covmat	Return the variance-covariance matrices? By default covmat=FALSE.
estimate	If TRUE nonparametric estimates are given. These include: transition probabilities, bivariate distribution function and marginal distribution of the second time (the last two only for the progressive three-state model).
time1	The first time for obtaining estimates for the transition probabilities, bivariate distribution function. NULL is equivalent to 0.
time2	The second time for obtaining estimates for the bivariate distribution function.
...	Further arguments for summary.



**Author(s)**

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**See Also**

[p3state](#)

**Examples**

```
data(heart2)
res.p3state<-p3state(heart2, formula=~age+year)
summary(res.p3state,model="CMM",time1=20,time2=100)
```

# Index

## \*Topic **datasets**

heart2, 3

Biv, 2

data.creation.reg, 3

heart, 3, 4

heart2, 3

p3state, 2, 4, 6, 7, 9

p3state.msm (p3state.msm-package), 2

p3state.msm-package, 2

pLIDA, 6

plot.p3state, 7

summary.p3state, 8