

# Package ‘Cprob’

February 14, 2012

**Title** Conditional probability function of a competing event

**Version** 1.2.1

**Author** Arthur Allignol

**Description** Estimates the conditional probability function of a competing event, and fits, using the temporal process regression or the pseudo-value approach, a proportional-odds model to the conditional probability function

**Maintainer** Arthur Allignol <arthur.allignol@fdm.uni-freiburg.de>

**Depends** prodlim, tpr, lattice, geepack

**License** GPL (>= 2)

**Repository** CRAN

**Date/Publication** 2011-05-02 16:52:11

## R topics documented:

Cprob-package . . . . .	2
cpf . . . . .	3
cpfpo . . . . .	5
lines.cpf . . . . .	7
mgus . . . . .	8
plot.cpf . . . . .	9
predict.cpf . . . . .	10
print.cpf . . . . .	11
print.cpfpo . . . . .	12
pseudocpf . . . . .	12
summary.cpf . . . . .	14
summary.pseudocpf . . . . .	15
xyplot.cpfpo . . . . .	16
<b>Index</b>	<b>17</b>

Cprob-package

*Conditional probability function of a competing event***Description**

Estimates the conditional probability function of a competing event, and fits, using the temporal process regression or the pseudo-value approach, a proportional-odds model to the conditional probability function

**Details**

Package: Cprob  
 Version: 1.0  
 Depends: prodlim, tpr, lattice, geepack  
 License: GPL (>=2)

**Index:**

cpf	Conditional Probability Function of a Competing Event
cpfpo	Proportional-odds Model for the Conditional Probability Function
lines.cpf	Lines method for 'cpf' objects
mgus	Monoclonal Gammopathy of Undetermined Significance
plot.cpf	Plot method for cpf objects
predict.cpf	Conditional Probability Estimates at chosen timepoints
print.cpf	Print a cpf object
print.cpfpo	Print Method for cpfpo objects
pseudocpf	Pseudo values for the conditional probability function
summary.cpf	Summary method for cpf
summary.pseudocpf	Summary method for pseudocpf objects
xyplot.cpfpo	'xyplot' method for object of class 'cpfpo'

The `cpf` function computes the conditional probability function of a competing event and can test equality of (only) two conditional probability curves.

A proportional-odds model for the conditional probability function can be fitted using either `cpfpo` or `pseudocpf`. The former function uses the temporal process regression methodology while the latter uses the pseudo value technique.

**Author(s)**

Arthur Allignol

Maintainer: Arthur Allignol <arthur.allignol@fdm.uni-freiburg.de>

## References

M.S. Pepe and M. Mori, Kaplan-Meier, marginal or conditional probability curves in summarizing competing risks failure time data? *Statistics in Medicine*, 12(8):737–751.

J.P. Fine, J. Yan and M.R. Kosorok (2004). Temporal Process Regression, *Biometrika*, 91(3):683–703.

A. Allignol, A. Latouche, J. Yan and J.P. Fine (2011). A regression model for the conditional probability of a competing event: application to monoclonal gammopathy of unknown significance. *Journal of the Royal Statistical Society: Series C*, 60(1):135–142.

P.K. Andersen, J.P. Klein and S. Rosthøj (2003). Generalised Linear Models for Correlated Pseudo-Observations, with Applications to Multi-State Models. *Biometrika*, 90, 15–27.

J.P. Klein and P.K. Andersen (2005). Regression Modeling of Competing Risks Data Based on Pseudovalues of the Cumulative Incidence Function. *Biometrics*, 61, 223–229.

## See Also

[tpr](#)

---

cpf

*Conditional Probability Function of a Competing Event*

---

## Description

This function computes estimates of the conditional probability function of a competing event and its variance. It also tests equality of conditional probability functions in two samples.

## Usage

```
cpf(formula, data, subset, na.action, conf.int = 0.95, failcode)
```

## Arguments

formula	A formula object that has a Hist object on the left of a ~ operator, and if desired, terms separated by + on the right. Note that any subsetting, i.e., data\$var or data[, "var"], is invalid for this function.
data	A data frame in which the variables in the formula can be interpreted.
subset	Expression identifying a subset of the data to be used for conditional probability estimation.
na.action	A missing-data filter function, applied to the model frame, after any subset argument has been used. Default option is options()\$na.action.
conf.int	Level for pointwise two-sided confidence intervals. Default is 0.95.
failcode	Failure code of the event of interest. Default is the smallest event type provided in the data.

## Details

The conditional probability function is defined as the probability of having failed due to one competing event (the event of interest), given that no other event has previously occurred (Pepe, 1993).

The cpf function aims at estimating this quantity along with its variance at each event times. It also computes a test of equality of conditional probability curves in two samples (and *only* in two samples).

Of note, if there is more than 2 competing events, the failure types that are not of interest are aggregated into one competing event.

## Value

cpf returns an object of class cpf with components

cp	Estimates of the conditional probability function given at all event times
var	Variance estimates
time	Event times
lower	Lower confidence limit for the conditional probability curve
upper	Upper confidence limit for the conditional probability curve
n.risk	Number of individuals at risk just before $t$
n.event	A matrix giving the number of events of interest at time $t$ in the first column, and the number of competing events at time $t$ in the second column
n.lost	Number of censored observations at time $t$
size.strata	Displays the size of each strata
X	Gives covariate's name and labels
strata	Gives the covariate labels that will be used by default for plotting the conditional probability curves, for example.
call	Call that produced the object
z	Test statistic
p	p value of the test
failcode	Same as in function call

## Author(s)

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

## References

M.S. Pepe and M. Mori, Kaplan-Meier, marginal or conditional probability curves in summarizing competing risks failure time data? *Statistics in Medicine*, 12(8):737–751.

A. Allignol, A. Latouche, J. Yan and J.P. Fine (2011). A regression model for the conditional probability of a competing event: application to monoclonal gammopathy of unknown significance. *Journal of the Royal Statistical Society: Series C*, 60(1):135–142.

**See Also**

[Hist](#), [print.cpf](#), [summary.cpf](#), [plot.survfit](#)

**Examples**

```
data(mgus)

CP <- cpf(Hist(time, ev), data = mgus)
CP

## With age dichotomised according to its median
mgus$AGE <- ifelse(mgus$age < 64, 0, 1)
CP <- cpf(Hist(time, ev)~AGE, data = mgus)
CP
summary(CP)

## Conditional probability of the competing event
CP.death <- cpf(Hist(time, ev), data = mgus, failcode = 2)
CP.death
```

---

cpfpo

*Proportional-odds Model for the Conditional Probability Function*


---

**Description**

This function uses the Temporal Process Regression framework to fit a proportional-odds model to the conditional probability function.

**Usage**

```
cpfpo(formula, data, subset, na.action, failcode, tis, w, ...)
```

**Arguments**

formula	A formula object whose response, on the left of a ~ operator, is a Hist object, and the terms on the right of ~
data	A data.frame in which to interpret the variable names in the formula and subset
subset	Expression specifying that only a subset of the data set should be used
na.action	A missing data filter function applied to the model.frame, after any subset argument has been used. Default is <code>options()\$na.action</code>
failcode	Integer specifying the code for the event of interest
tis	Vector of timepoints on which the model is fitted
w	Vector of weights. Should be of the same length as tis. Default is <code>rep(1, length(tis))</code>
...	Further arguments for <a href="#">tpr</a>

## Details

The conditional probability function of a competing event is the probability of having failed due to one risk (the event of interest) given that no other failure has previously occurred.

The `cpfpo` function fits a proportional-odds model for the conditional probability function within the Temporal Process Regression framework, which is a marginal mean model, where the mean of a response  $Y(t)$  at time  $t$  is specified conditionally on a vector of covariates  $Z$  and a time-dependent stratification factor  $S(t)$

$$E\{Y(t)|Z, S(t) = 1\} = g^{-1}\{\beta(t)'Z\}$$

This approach enables the application of standard binary regression models in continuous time.

The regression model is fitted using the **tpr** package. See [tpr](#) for further details.

## Value

`cpfpo` returns an object of class `cpfpo` and [tpr](#). See [tpr](#) for further details.

## Note

As the returned value is also a `tpr` object, all the methods defined in the **tpr** package are available.

## Author(s)

Arthur Allignol, <[arthur.allignol@fdm.uni-freiburg.de](mailto:arthur.allignol@fdm.uni-freiburg.de)>

## References

J.P. Fine, J. Yan and M.R. Kosorok (2004). Temporal Process Regression, *Biometrika*, 91(3):683-703.

M.S. Pepe and M. Mori, Kaplan-Meier, marginal or conditional probability curves in summarizing competing risks failure time data? *Statistics in Medicine*, 12(8):737-751.

A. Allignol, A. Latouche, J. Yan and J.P. Fine (2011). A regression model for the conditional probability of a competing event: application to monoclonal gammopathy of unknown significance. *Journal of the Royal Statistical Society: Series C*, 60(1):135-142.

## See Also

[tpr](#), [print.cpfpo](#), [xyplot.cpfpo](#)

## Examples

```
data(mgus)
mgus$A <- ifelse(mgus$age < 64, 0, 1)

## fit the model for 2 covariates
fit.cpfpo <- cpfpo(Hist(time, ev)~factor(A) + creat,
                  data = mgus, tis=seq(10, 30, 0.3),
                  w=rep(1,67))
## and plot the odds-ratios
xyplot(fit.cpfpo, scales = list(relation = "free"), layout = c(3, 1))
```

---

lines.cpf                      *Lines method for 'cpf' objects*

---

## Description

Lines method for cpf objects

## Usage

```
## S3 method for class 'cpf'  
lines(x, conf.int = FALSE, mark.time = FALSE, mark = 3,  
      col = 1, lty, ci.lty = 3, ...)
```

## Arguments

x	An object of class cpf
conf.int	Logical. Whether to add a pointwise confidence interval
mark.time	Controls the labelling of the curves. If set to TRUE, then the curves are marked at each occurrence of a competing event
mark	Mark parameter which will be used to label the curves. Same as pch
col	A vector of colours
lty	A vector specifying the line types for the curves
ci.lty	A vector specifying the line type for the confidence intervals
...	Other arguments

## Value

No value returned

## Author(s)

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

## See Also

[plot.cpf](#)

---

mgus

*Monoclonal Gammopathy of Undetermined Significance*

---

### Description

All 241 patients diagnosed with monoclonal gammopathy of undetermined significance at the Mayo Clinic before Jan. 1, 1971, and followed forward until 1992. The interest lies in the possible transformation of mgus towards a cancer of the plasma cells, death from other causes acting as a competing risk.

### Usage

```
data(mgus)
```

### Format

A data frame with 241 observations and the following 10 variables.

id Patient identification number

time Event time

ev Event type. 0=censored, 1=cancer of the plasma cells, 2=other

age Age at diagnostic of mgus

sex Sex. 1=male, 2=female

y.diag Calendar year of diagnosis

albu Albumine level at mgus diagnosis

creat Serum creatinine level at mgus diagnosis

Hb Hemoglobine level at mgus diagnosis

size Size of the monoclonal protein peak at mgus diagnosis

### Source

T.M. Therneau and P.M. Grambsch (2001). *Modelling Survival Data: Extending the Cox Model*. Springer, New York.

### Examples

```
data(mgus)
```

---

plot.cpf	<i>Plot method for cpf objects</i>
----------	------------------------------------

---

**Description**

A plot of conditional probability curves is produced, one for each strata. Pointwise confidence intervals and legend can also be displayed

**Usage**

```
## S3 method for class 'cpf'
plot(x, conf.int = FALSE, mark.time = FALSE, mark = 3,
      col = 1, lty, ci.lty = 3, xlim, ylim = c(0, 1),
      xlab = "", ylab = "", bty = "n", legend = TRUE,
      curvlab = NULL, legend.pos = NULL,
      legend.bty = "n", ...)
```

**Arguments**

<code>x</code>	An object of class <code>cpf</code>
<code>conf.int</code>	A logical indicating whether to plot a pointwise confidence interval. Default is <code>FALSE</code>
<code>mark.time</code>	Controls the labelling of the curves. If set to <code>TRUE</code> , then the curves are marked at each occurrence of a competing event
<code>mark</code>	Mark parameter which will be used to label the curve. The same as <code>pch</code>
<code>col</code>	Vector of colours for the curves
<code>lty</code>	Vector of integers specifying the line types
<code>ci.lty</code>	A vector of integer controlling the line types for the pointwise confidence intervals
<code>xlim</code>	x-axis limits for the plot area. Default is <code>c(0, 1)</code>
<code>ylim</code>	y-axis limits for the plot area
<code>xlab</code>	x-axis label
<code>ylab</code>	y-axis label
<code>bty</code>	see <a href="#">par</a>
<code>legend</code>	Whether or nor draw a legend. Default is <code>TRUE</code>
<code>curvlab</code>	Text for legend
<code>legend.pos</code>	Position for the legend. Default is the upper left corner
<code>legend.bty</code>	Box type. See <a href="#">legend</a>
<code>...</code>	Further arguments for plot

**Value**

No value returned

**Author(s)**

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

**See Also**

[par](#), [cpf](#)

**Examples**

```
data(mgus)
mgus$A <- ifelse(mgus$age < 64, 0, 1)

fit <- cpf(Hist(time, ev)~A, mgus)

plot(fit, curvlab = c("Age < 64", "Age >= 64"),
     main = "Conditional Probability of Cancer", xlab = "Years")
```

---

predict.cpf

*Conditional Probability Estimates at chosen timepoints*

---

**Description**

This function displays estimates of the conditional probability function at timepoints chosen by the user

**Usage**

```
## S3 method for class 'cpf'
predict(object, timepoints, ...)
```

**Arguments**

object	An object of class <code>cpf</code>
timepoints	Vector of timepoints
...	Not used

**Value**

A data.frame with the following columns

time	The given timepoints
cp	Conditional probability estimates
var	Variance estimates
lower	Lower confidence limit
upper	Upper confidence limit
n.risk	Number of individuals at risk just before the timepoints
group	Group, if any

**Author(s)**

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

**See Also**

[cpf](#)

**Examples**

```
data(mgus)
mgus$A <- ifelse(mgus$age < 64, 0, 1)

test <- cpf(Hist(time, ev)~A, data = mgus)

predict(test, c(10, 20))
```

---

`print.cpf`                      *Print a cpf object*

---

**Description**

Print method for a cpf object

**Usage**

```
## S3 method for class 'cpf'
print(x, ...)
```

**Arguments**

`x`                      A cpf object  
`...`                    Further arguments to the print method. Not used here.

**Value**

No value returned.

**Author(s)**

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

**See Also**

[cpf](#)

---

print.cpfpo                    *Print Method for cpfpo objects*

---

### Description

A print method for an object of class cpfpo. It displays the results of test for non-significant effects, along with the results of the test for time-independent effects.

### Usage

```
## S3 method for class 'cpfpo'
print(x, ...)
```

### Arguments

x	An object of class cpfpo
...	Not used

### Value

An invisible list with 2 components

sig	Results of the test on non-significant effects
tdep	Results of the test on the time-dependence of the effects

See [tpr.test](#)

### Author(s)

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

### See Also

[tpr.test](#), [cpfpo](#)

---

pseudocpf                    *Pseudo values for the conditional probability function*

---

### Description

The function computes pseudo values and then fit a proportional-odds model to the conditional probability function using GEE

### Usage

```
pseudocpf(formula, data, id, subset, na.action, timepoints,
           failcode = 1, ...)
```

**Arguments**

formula	A formula object, whose terms are on the right of a ~ operator and the response, a Hist object, on the left
data	A data frame in which to interpret the formula
id	Individual patient id
subset	Expression specifying that only a subset of the data set should be used
na.action	A missing data filter function applied to the model.frame, after any subset argument has been used. Default is options()\$na.action
timepoints	Time points at which to compute the pseudo values
failcode	Integer that specifies which event is of interest
...	Other arguments for the <a href="#">geese</a> function

**Details**

The regression model is fitted using a method based on the pseudo-values from a jackknife statistic constructed from the conditional probability curve. Then a GEE model is used on the pseudovalues to obtain the odds-ratios.

**Value**

Returns an object of class pseudocpf containing the following components:

fit	A geese object
pseudo	The pseudo values computed at the specified time points
timepoints	Same as in the function call
call	The matched call

**Note**

Besides the estimated regression coefficients, the function returns the computed pseudo-values, so that one can fit a different model, e.g., with a different link function.

**Author(s)**

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

**References**

- P.K. Andersen, J.P. Klein and S. Rosthøj (2003). Generalised Linear Models for Correlated Pseudo-Observations, with Applications to Multi-State Models. *Biometrika*, 90, 15-27.
- J.P. Klein and P.K. Andersen (2005). Regression Modeling of Competing Risks Data Based on Pseudovalues of the Cumulative Incidence Function. *Biometrics*, 61, 223-229.

**See Also**

[geese](#), [summary.pseudocpf](#)

**Examples**

```

data(mgus)

cutoffs <- quantile(mgus$time, probs = seq(0, 1, 0.05))[-1]

### with fancy variance estimation
fit1 <- pseudocpf(Hist(time, ev) ~ age + creat, mgus, id = id,
                 timepoints = cutoffs, corstr = "independence",
                 scale.value = TRUE)
summary(fit1)

### with jackknife variance estimation
fit2 <- pseudocpf(Hist(time, ev) ~ age + creat, mgus, id = id,
                 timepoints = cutoffs, corstr = "independence",
                 scale.value = TRUE, jack = TRUE)
summary(fit2)

```

summary.cpf

*Summary method for cpf***Description**

Provides a summary of a cpf object.

**Usage**

```

## S3 method for class 'cpf'
summary(object, ...)
## S3 method for class 'summary.cpf'
print(x, ...)

```

**Arguments**

object	An object of class cpf
x	An object of class summary.cpf
...	Not used

**Value**

A list with the following components

est	A list of data.frame according to the covariate number of levels. Each data.frame contains conditional probability estimates, variance estimates, number of individual at risk at each event times, number of events for the event of interest, number of competing events, and the event times.
call	Call that produced the cpf object
X	Covariate's name and levels
z, p	Test statistic and p value

**Author(s)**

arthur allignol, <arthur.allignol@fdm.uni-freiburg.de>

**See Also**

[cpf](#)

---

summary.pseudocpf      *Summary method for pseudocpf objects*

---

**Description**

Summary method for pseudocpf objects

**Usage**

```
## S3 method for class 'pseudocpf'
summary(object, conf.int = 0.95, scale = 1, ...)
```

**Arguments**

object	An object of class pseudocpf
conf.int	Level for the two-sided confidence intervals
scale	Vector of scale factors for the coefficients, defaults to 1. The confidence limits are for the risk change associated with one scale unit
...	Other arguments

**Value**

Returns an object of class summary.pseudocpf that includes the following components:

call	The matched call
coefficients	A matrix with 5 columns including the regression coefficients, odds-ratios, standard-errors, wald statistics and corresponding two-sided p-values
conf.int	A matrix with 4 columns that consists of the odds-ratios, exp(-coef) and the lower and upper bounds of the confidence interval

**Author(s)**

Arthur Allignol, <arthur.allignol@fdm.uni-freiburg.de>

**See Also**

[pseudocpf](#)

---

`xyplot.cpfpo`*'xyplot' method for object of class 'cpfpo'*

---

### Description

This function plots the results of the proportional-odds model fitted to the conditional probability function using [cpfpo](#).

### Usage

```
## S3 method for class 'cpfpo'
xyplot(x, data = NULL, conf.int = TRUE, level = 0.95,
       odds = TRUE, intercept = TRUE, ylab, xlab, lty = c(1, 3, 3),
       col = c(1, 1, 1), ...)
```

### Arguments

<code>x</code>	An object of class <code>cpfpo</code>
<code>data</code>	<i>Useless</i> . Can be kept to <code>NULL</code>
<code>conf.int</code>	Logical. Whether to plot pointwise confidence intervals. Default is <code>TRUE</code>
<code>level</code>	Level of the pointwise confidence interval. Default is <code>0.95</code>
<code>odds</code>	If set to <code>TRUE</code> , the odds-ratios are displayed. Otherwise their logs are plotted. Default is <code>TRUE</code>
<code>intercept</code>	Logical. Controls whether the intercept should also be displayed. Default is <code>TRUE</code> .
<code>ylab</code>	Label for the y-axis
<code>xlab</code>	Label for the x-axis
<code>lty</code>	Vector of line types. Default is 1 for the odds-ratio and 3 for the confidence interval.
<code>col</code>	A vector of colours. Default is black
<code>...</code>	Further arguments

### Value

The function returns a trellis object. See [xyplot](#) for further details.

### Author(s)

Arthur Allignol, <[arthur.allignol@fdm.uni-freiburg.de](mailto:arthur.allignol@fdm.uni-freiburg.de)>

### See Also

[cpfpo](#), [xyplot](#)

# Index

\*Topic **datasets**

mgus, 8

\*Topic **hplot**

lines.cpf, 7

plot.cpf, 9

xyplot.cpfpo, 16

\*Topic **package**

Cprob-package, 2

\*Topic **print**

print.cpf, 11

print.cpfpo, 12

summary.cpf, 14

summary.pseudocpf, 15

\*Topic **regression**

cpfpo, 5

pseudocpf, 12

\*Topic **survival**

cpf, 3

cpfpo, 5

Cprob-package, 2

lines.cpf, 7

mgus, 8

plot.cpf, 9

predict.cpf, 10

pseudocpf, 12

summary.cpf, 14

summary.pseudocpf, 15

xyplot.cpfpo, 16

[.cpf (cpf), 3

cpf, 3, 10, 11, 15

cpfpo, 5, 12, 16

Cprob (Cprob-package), 2

Cprob-package, 2

geese, 13

Hist, 5

legend, 9

lines.cpf, 7

mgus, 8

par, 9, 10

plot.cpf, 7, 9

plot.survfit, 5

predict.cpf, 10

print.cpf, 5, 11

print.cpfpo, 6, 12

print.summary.cpf (summary.cpf), 14

print.summary.pseudocpf

(summary.pseudocpf), 15

pseudocpf, 12, 15

summary.cpf, 5, 14

summary.pseudocpf, 13, 15

tpr, 3, 5, 6

tpr.test, 12

xyplot, 16

xyplot.cpfpo, 6, 16