

# Package ‘wnpml’

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**Title** Weighted NPMLE for Recurrent Events with a Competing Terminal Event

**Version** 0.1.2

**Description** Provides regression modeling and prediction for the marginal mean of recurrent events in the presence of a competing terminal event using the weighted nonparametric maximum likelihood estimator (wNPMLE) of Bellach and Kosorok (2026)  [<doi:10.48550/arXiv.2605.25934>](https://doi.org/10.48550/arXiv.2605.25934). Two classes of transformation models are implemented: Box-Cox transformation models and logarithmic transformation models. These extend the proportional means model of Ghosh and Lin (2002)  [<doi:10.17615/pt0g-y207>](https://doi.org/10.17615/pt0g-y207) and the transformation model framework of Zeng and Lin (2006)  [<doi:10.1093/biomet/93.3.627>](https://doi.org/10.1093/biomet/93.3.627). Parameter estimation is performed using automatic differentiation through the Template Model Builder (TMB) framework. Standard errors are computed using sandwich variance estimators that account for estimation of the inverse-probability censoring weights following Bellach, Kosorok, Rüschemdorf and Fine (2019)  [<doi:10.1080/01621459.2017.1401540>](https://doi.org/10.1080/01621459.2017.1401540).

**License** GPL (>= 3)

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**Imports** TMB (>= 1.9.0), survival, methods, MASS, graphics, grDevices

**Suggests** testthat (>= 3.0.0), knitr, rmarkdown

**Config/testthat/edition** 3

**VignetteBuilder** knitr

**URL** <https://github.com/abellach/wnpml>

**BugReports** <https://github.com/abellach/wnpml/issues>

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AIC.wnpml	<i>AIC for wnpml objects</i>
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## Description

AIC for wnpml objects

## Usage

```
## S3 method for class 'wnpml'
AIC(object, ..., k = 2)
```

## Arguments

object	A wnpml object.
...	Ignored.
k	Penalty per parameter (default 2 for AIC).

## Value

A numeric scalar giving the AIC value.

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baseline	<i>Extract the estimated baseline mean function</i>
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### Description

Returns a data frame with the estimated cumulative baseline mean function  $\Lambda(t)$  and its increments  $\lambda(t)$ , together with standard errors and pointwise 95% confidence intervals.

### Usage

```
baseline(object, conf_level = 0.95, ...)
```

### Arguments

object	A <code>wnpml</code> object.
conf_level	Confidence level for the pointwise intervals (default 0.95).
...	Ignored.

### Value

A data frame with columns:

time	Recurrent event times.
lambda	Estimated baseline increments.
Lambda	Estimated cumulative baseline mean.
se_Lambda	Standard error of Lambda (if SE was estimated).
lower	Lower confidence band for Lambda.
upper	Upper confidence band for Lambda.

### Examples

```
bdata <- bladder_prep()
bdata_clean <- bdata[, c("id", "time", "status", "treat", "num", "size")]
fit <- wnpml_fit(Surv(time, status) ~ treat + num + size,
                 data = bdata_clean, id = "id", model = "log", rho = 1)
bl <- baseline(fit)
head(bl)
```

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BIC.wnple	<i>BIC for wnple objects</i>
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**Description**

BIC for wnple objects

**Usage**

```
## S3 method for class 'wnple'
BIC(object, ...)
```

**Arguments**

object	A wnple object.
...	Ignored.

**Value**

A numeric scalar giving the BIC value.

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bladder_prep	<i>Prepare bladder cancer data for wnple analysis</i>
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**Description**

Prepares the bladder1 dataset from the **survival** package for use with [wnple\\_fit](#). Subjects randomised to pyridoxine are excluded (only placebo and thiotepa arms are retained). Status codes are recoded to 0 (censored), 1 (recurrent tumour), 2 (terminal/dropout), and event times beyond tau are truncated to tau.

**Usage**

```
bladder_prep(tau = 59)
```

**Arguments**

tau	Follow-up truncation time (default: 59 months). Event times beyond tau are set to tau.
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**Details**

The bladder cancer trial (Veterans Administration Cooperative Urological Research Group) randomised patients to placebo, pyridoxine, or thiotepa. Only the placebo and thiotepa arms are used here (pyridoxine arm excluded). Subjects with event times equal to tau and status 0 have their times truncated to tau, consistent with administrative censoring.

**Value**

A data frame with columns:

id	Subject identifier (integer).
status	Event status: 0 = censored, 1 = recurrent event, 2 = terminal event.
status0	Indicator: 1 if censored.
status1	Indicator: 1 if recurrent event.
status2	Indicator: 1 if terminal event.
time	Event time (months).
treat	Treatment indicator: 1 = thiotepa, 0 = placebo.
num	Initial number of tumours.
size	Initial tumour size (cm).

**References**

Byar, D.P. (1980). The Veterans Administration study of chemoprophylaxis for recurrent stage I bladder tumors. In *Bladder Tumors and Other Topics in Urological Oncology*, 363-370. Plenum, New York.

**Examples**

```
bdata <- bladder_prep(tau = 59)
head(bdata)
table(bdata$status)
```

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 coef.wnqml

*Extract coefficients from a wnqml object*

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**Description**

Extract coefficients from a wnqml object

**Usage**

```
## S3 method for class 'wnqml'
coef(object, ...)
```

**Arguments**

object	A wnqml object.
...	Ignored.

**Value**

A named numeric vector of regression coefficients.

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logLik.wnrmle	<i>Log-likelihood for wnrmle objects</i>
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**Description**

Log-likelihood for wnrmle objects

**Usage**

```
## S3 method for class 'wnrmle'
logLik(object, ...)
```

**Arguments**

object	A wnrmle object.
...	Ignored.

**Value**

An object of class "logLik" with the log-likelihood value, degrees of freedom (df) equal to the number of regression coefficients, and number of observations (nobs).

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plot.wnrmle	<i>Plot method for wnrmle objects</i>
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**Description**

Plots the estimated cumulative baseline mean function  $\Lambda(t)$  with optional pointwise confidence bands.

**Usage**

```
## S3 method for class 'wnrmle'
plot(x, conf_bands = TRUE, ...)
```

**Arguments**

x	A wnrmle object.
conf_bands	Logical; if TRUE (default), adds pointwise 95% confidence bands when available.
...	Additional graphical parameters passed to plot.

**Value**

No return value, called for side effects (produces a plot).

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plot\_loglik

*Log-likelihood profile plot for the transformation parameter*


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### Description

Fits the model over a fine grid of transformation parameter values and plots the profile log-likelihood for both the Box-Cox and logarithmic transformation models on a single plot. The log transformation parameter  $r$  is shown on the left (negative axis) and the Box-Cox parameter  $\rho$  on the right (positive axis), meeting at zero where both models coincide.

### Usage

```
plot_loglik(
  formula,
  data,
  id = "id",
  rho_grid = seq(0.01, 1.2, by = 0.01),
  r_grid = seq(0.01, 1.2, by = 0.01),
  tau = NULL,
  mark_points = TRUE,
  file = NULL,
  verbose = TRUE,
  ...
)
```

### Arguments

formula	A formula as passed to <a href="#">wnpml_fit</a> .
data	A data frame.
id	Name of the subject identifier column.
rho_grid	A numeric vector of $\rho$ values for the Box-Cox model (default: <code>seq(0.01, 1.2, by = 0.01)</code> ).
r_grid	A numeric vector of $r$ values for the log model (default: <code>seq(0.01, 1.2, by = 0.01)</code> ).
tau	Optional truncation time. If NULL (default), uses the maximum observed time in the data.
mark_points	Logical; if TRUE (default), marks reference points at $\rho=1$ (filled circle, Ghosh-Lin) and $r=1$ (open circle, proportional odds model).
file	Optional path to save the plot as a PDF (e.g. "loglik_profile.pdf"). If NULL (default), plots to the current device.
verbose	Logical; print progress (default TRUE).
...	Additional arguments passed to <a href="#">wnpml_fit</a> .

**Value**

A data frame with columns model, param and loglik, invisibly.

**Examples**

```
bdata <- bladder_prep()
bdata_clean <- bdata[, c("id", "time", "status", "treat", "num", "size")]
plot_loglik(Surv(time, status) ~ treat + num + size,
            data = bdata_clean, id = "id")
```

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predict.wnplye	<i>Predict marginal mean for new covariate values</i>
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**Description**

Predict marginal mean for new covariate values

**Usage**

```
## S3 method for class 'wnplye'
predict(object, newdata = NULL, times = NULL, ...)
```

**Arguments**

object	A wnplye object.
newdata	A data frame with the same covariates used in fitting. If NULL, returns the estimated Lambda(t) for the baseline (all covariates = 0).
times	Time points at which to evaluate the marginal mean. If NULL, uses the observed recurrent event times.
...	Ignored.

**Value**

A data frame with columns time and one column per row of newdata (or a single column mu for baseline).

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print.wnrmle	<i>Print method for wnrmle objects</i>
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**Description**

Print method for wnrmle objects

**Usage**

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

**Arguments**

x	A wnrmle object.
...	Ignored.

**Value**

Invisibly returns x.

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summary.wnrmle	<i>Summary method for wnrmle objects</i>
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**Description**

Summary method for wnrmle objects

**Usage**

```
## S3 method for class 'wnrmle'
summary(object, tau_grid = TRUE, ...)
```

**Arguments**

object	A wnrmle object.
tau_grid	Logical; if TRUE (default), also show Lambda at tau/4, tau/2, and tau.
...	Ignored.

**Value**

Invisibly returns object.

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vcov.wnpmle	<i>Extract variance-covariance matrix from a wnpmle object</i>
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**Description**

Returns the full variance-covariance matrix for (beta, Lambda). To get only the beta part, use `vcov(fit)[1:p, 1:p]`.

**Usage**

```
## S3 method for class 'wnpmle'
vcov(object, ...)
```

**Arguments**

object	A wnpmle object.
...	Ignored.

**Value**

A numeric matrix containing the variance-covariance matrix for the regression coefficients and cumulative baseline mean function. Returns an error if `se = "none"` was used in `wnpmle_fit`.

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wnpmle_fit	<i>Fit Weighted NPMLE for Survival Data with Recurrent or Competing Events</i>
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**Description**

Estimates the weighted nonparametric maximum likelihood estimator (wNPMLE) for the marginal mean function of recurrent events in the presence of a competing terminal event. Two transformation models are supported: the Box-Cox model and the logarithmic model.

**Usage**

```
wnpmle_fit(
  formula,
  data,
  id = "id",
  type = c("recurrent", "cmprsk", "cmprsk_ltrc"),
  model = c("boxcox", "log"),
  rho = 1,
  tau = NULL,
  se = c("sandwich_adj", "sandwich", "fisher", "none"),
  init_beta = NULL,
  control = list(),
  silent = TRUE
)
```

**Arguments**

formula	A formula of the form $\text{Surv}(\text{time}, \text{status}) \sim \text{covariates}$ , where status takes value 1 for a recurrent event, 2 for the terminal event (e.g. death), and 0 for censoring.
data	A data frame containing the variables in formula and an id column identifying subjects.
id	Name of the subject identifier column in data (default: "id").
type	Type of analysis. Currently only "recurrent" is supported (recurrent events with a competing terminal event). Future versions will add "cmprsk" (competing risks) and "cmprsk_ltrc" (competing risks with left truncation and right censoring).
model	Transformation model: "boxcox" (default) or "log".
rho	Transformation parameter. For model = "boxcox", this is the Box-Cox parameter rho (default 1, i.e. linear/proportional means model). For model = "log", this is the parameter r in $G(x) = \log(1 + r \cdot x) / r$ (default 1).
tau	Follow-up truncation time. Kaplan-Meier censoring weights are truncated at tau. If NULL (default), uses the maximum observed time.
se	Variance estimation method: "sandwich_adj" (default, sandwich with censoring correction), "sandwich" (plain sandwich), "fisher" (inverse Hessian), or "none".
init_beta	Initial values for regression coefficients (default: all zeros).
control	A list of control parameters passed to <code>nlm</code> .
silent	Suppress TMB output (default: TRUE).

**Details**

**Analysis types:** Currently only type = "recurrent" is implemented, for the recurrent events with competing terminal event setting. Support for "cmprsk" (Bellach, Kosorok, Ruschendorf and Fine, 2019) and "cmprsk\_ltrc" (left truncation and right censoring) will be added in future versions.

**Transformation models:** The two models differ in the link function  $G$ :

- **Box-Cox:**  $G(x) = ((1 + x)^\rho - 1) / \rho$ , with  $G(x) \rightarrow \log(1 + x)$  as  $\rho \rightarrow 0$ .
- **Logarithmic:**  $G(x) = \log(1 + r \cdot x) / r$ , with  $G(x) \rightarrow x$  as  $r \rightarrow 0$ .

Both are estimated via automatic differentiation using TMB. The sandwich variance estimator accounts for the estimation of the censoring weights. The censoring-corrected sandwich (sandwich\_adj) adds an influence function correction for the Kaplan-Meier censoring weight estimation.

**Value**

An object of class "wnpml" with components:

coefficients	Estimated regression coefficients (beta).
se	Standard errors for the regression coefficients.
Lambda	Estimated cumulative baseline mean function, evaluated at the recurrent event times.



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