Package 'PERSUADE'

October 6, 2025

Title Parametric Survival Model Selection for Decision-Analytic Models

Version 0.1.2

Description Provides a standardized framework to support the selection and evaluation of parametric survival models for time-to-event data. Includes tools for visualizing survival data, checking proportional hazards assumptions (``Grambsch" and ``Therneau" (1994) <doi:10.1093/biomet/81.3.515>), comparing parametric (``Ishak" and colleagues (2013) <doi:10.1007/s40273-013-0064-3>), spline (``Royston" and ``Parmar" (2002) <doi:10.1002/sim.1203>) and cure models, examining hazard functions, and evaluating model extrapolation. Methods are consistent with recommendations in the NICE Decision Support Unit Technical Support Documents 14 and 21 <https://sheffield.ac.uk/nice-dsu/tsds/survival-analysis>. Results are structured to facilitate integration into decision-analytic models, and reports can be generated with 'rmarkdown'. The package builds on existing tools including 'flexsurv' (``Jackson" (2016) <doi:10.18637/jss.v070.i08>) and 'flexsurvcure' for estimating cure models.

License GPL (>= 3)

Depends R (>= 4.1.0)

Imports data.table,
flexsurv,
flexsurvcure,
ggplot2,
muhaz,
rmarkdown,
rms,
sft,
stats,
survival,
survminer

Suggests kableExtra,
knitr,
testthat (>= 3.1.2),
utils

VignetteBuilder knitr

Config/testthat/edition 3

Encoding UTF-8

LazyData true

Roxygen list(markdown = TRUE)

RoxygenNote 7.3.2

Contents

`f_cum_hazard` *Calculate Cumulative Hazard Estimates*

Description

Computes cumulative hazard estimates for up to three groups along with variance and confidence intervals, using the **estimateNAH** package.

Usage

```
f_cum_hazard(years, status, group, ngroups, time_pred, time_unit)
```

Arguments

`years`	Numeric vector of time-to-event data.
`status`	Numeric vector indicating event occurrence (1 = event, 0 = censoring).
`group`	Factor indicating group membership.
`ngroups`	Integer. Number of groups (1-3).
`time_pred`	Numeric vector of prediction times.
`time_unit`	Numeric. Time unit length for scaling.

Value

A data frame with columns:

- `group`: Group identifier.
- `time`: Prediction times.
- `H`: Cumulative hazard values.
- `var`: Variance estimates.
- `H_upper`, `H_lower`: 95% confidence interval bounds.
- `H_delta`, `H_upper_delta`, `H_lower_delta`: Differences between time steps.

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
f_cum_hazard(
  years = years,
  status = status,
  group = group,
  ngroups = nlevels(group),
  time_pred = seq(0, 5000, 365.25),
  time_unit = 30
)
```

`f_generate_report` *Generate PDF Report for a PERSUADE Analysis*

Description

Save the PERSUADE object and render a PDF report using the bundled `PERSUADE_output.Rmd` template, or a user-specified template.

Usage

```
f_generate_report(
  PERSUADE,
  output_dir = NULL,
  template_dir = NULL,
  open = FALSE
)
```

Arguments

`PERSUADE`	A PERSUADE object returned by `f_PERSUADE()`.
`output_dir`	Character string giving the directory to copy the function output to. If `NULL` (the default), the function uses: `file.path(tempdir(), paste0(PERSUADE$name, "_output"))`. Change `tempdir()` into `getwd()` for copying to working directory.
`template_dir`	Optional character string giving the full path to an Rmd template. If `NULL` (the default), the function looks for `PERSUADE_output.Rmd` within the package installation directory.
`open`	Logical. Whether to browse the generated file.

Details

The default R markdown file `PERSUADE_output.Rmd` is stored within the package under `inst/rmd/`. Figures are written to a subdirectory `Images/` inside the output folder, and the knit environment is initialised with the supplied `PERSUADE` object. Supplying a custom `template_dir` allows alternative report formats to be used, and simplifies testing. This function requires the following suggested packages: **knitr**, **kableExtra**, and **rmarkdown**. If not installed, the function will throw an error.

Value

A length-1 character string giving the absolute path to the generated PDF, returned invisibly.

See Also

`f_PERSUADE()`

Examples

```
## Not run:  # Requires LaTeX to be installed
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
# Copy output to temporary directory
# (change `tempdir()` into `getwd()`
# for copying to working directory)
f_generate_report(
  PERSUADE,
  output_dir = file.path(
  tempdir(), paste0(PERSUADE$name, "_output")
  ),
  template_dir = NULL
)

## End(Not run)
```

---

f_get_excel_template *Copy Excel Template for Model Parameters*

Description

Copy the bundled Excel template `PERSUADE_Excel_template.xltx` to a user-specified directory. This template provides a convenient structure for transferring survival model outputs from **PERSUADE** into health economic models.

Usage

```
f_get_excel_template(output_dir = NULL)
```

Arguments

`output_dir`	Character string giving the directory to copy the template to. If `NULL` (the default), the function uses: `tempdir()`. Change `tempdir()` into `getwd()` for copying to working directory.

Details

The default Excel file `PERSUADE_Excel_template.xltx` is stored within the package under `inst/excel_template/`. This function locates the installed file via `system.file()` and copies it into the requested directory. If a file with the same name already exists at the destination, it will be overwritten.

The Excel template provides a standardized format for entering parametric survival model parameters, making it easier to use PERSUADE outputs in downstream decision-analytic models. Users may adapt the template as needed for their specific workflows.

Value

A length-1 character string giving the absolute path to the copied template file, returned invisibly.

See Also

`f_generate_report()`, `system.file()`

Examples

```
# Copy output to temporary directory
# (change `tempdir()` into `getwd()` for
# copying to working directory)
f_get_excel_template(
output_dir = file.path(tempdir(), paste0("BC_OS", "_output"))
)
```

---

f_hazard *Calculate Smoothed Hazard Estimates*

Description

Computes smoothed hazard estimates for up to three groups using the **muhaz** package.

Usage

```
f_hazard(years, status, group, ngroups)
```

Arguments

`years`	Numeric vector of time-to-event data.
`status`	Numeric vector indicating event occurrence (1 = event, 0 = censoring).
`group`	Factor indicating group membership.
`ngroups`	Integer. Number of groups (1-3).

Value

A list with elements:

- `hazards`: List of hazard objects (one per group).
- `names`: Vector of group identifiers for hazard values.
- `max`: Data frame with maximum time and hazard values.

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
f_hazard(
  years = years,
  status = status,
  group = group,
  ngroups = nlevels(group)
)
```

---

f_PERSUADE *Main PERSUADE Function*

Description

Executes the PERSUADE workflow for parametric survival analysis, including Kaplan-Meier, parametric, spline, and cure models. Produces outputs for visualization, prediction, and Excel export.

Usage

```
f_PERSUADE(
  name = "no_name",
  years,
  status,
  group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  cure_link = "logistic",
  time_unit,
  time_horizon,
  time_pred_surv_table
)
```

Arguments

name	Character. Name identifier for the analysis (default: "no_name").
years	Numeric vector of time-to-event data.
status	Numeric vector indicating event occurrence (1 = event, 0 = censoring).
group	Factor indicating group membership.
strata	Logical. Whether to stratify models by group.
spline_mod	Logical. Whether spline models should be fitted.
cure_mod	Logical. Whether cure models should be fitted.
cure_link	Character string specifying the link function for cure models ("logistic", "loglog", "identity", "probit"; default = "logistic").
time_unit	Numeric. The unit of time for annualization.
time_horizon	Numeric. The maximum prediction time horizon.
time_pred_surv_table	Numeric vector of time points for survival table predictions.

Details

The workflow proceeds in three main stages:

1. Observed data (Kaplan-Meier, hazards, Cox regression).
2. Parametric, spline, and cure model fitting.
3. Prediction and export of results.

Value

A list of class `"PERSUADE"` containing:

- `input`: Input arguments used in the analysis.
- `surv_obs`: Observed survival results (Kaplan-Meier, hazards, Cox model).
- `surv_model`: Fitted parametric/spline/cure models.
- `surv_pred`: Model predictions.
- `surv_model_excel`: Excel-ready parameter table.
- `misc`: Auxiliary results (labels, number of groups, etc.).

See Also

`f_hazard()`, `f_cum_hazard()`, `f_surv_model()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
```

---

f_plot_cure_surv_extrap

Plot Extrapolated Cure Survival Models per Group

Description

Plot Kaplan-Meier curves per group with shaded confidence bands and overlay fitted cure survival models (Weibull, log-normal, log-logistic; mixture and non-mixture forms) extrapolated to the analysis time horizon. Runs only when `PERSUADE$input$cure_mod` is `TRUE`.

Usage

```
f_plot_cure_surv_extrap(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object returned by f_PERSUADE().

Value

Invisibly returns NULL. The function draws one or more base R plots as side effects.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = TRUE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_cure_surv_extrap(PERSUADE)
```

---

f_plot_cure_surv_model

Cure Survival Model Overlay

Description

Overlays a fitted cure survival model on KM curves, including shaded KM confidence bands per group.

Usage

```
f_plot_cure_surv_model(PERSUADE, model_index = 1)
```

Arguments

PERSUADE	A PERSUADE object created by f_PERSUADE().
model_index	Integer. Index of the cure model in PERSUADE$surv_pred$model$cure.

Value

A base R plot of KM curves with cure model overlays.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = TRUE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_cure_surv_model(PERSUADE, model_index = 1)
```

---

f_plot_diag_cure_surv_model

Diagnostic Plot for Cure Survival Models

Description

Produces diagnostic plots for mixture and non-mixture cure survival models, using transformations depending on the underlying distribution (Weibull, log-normal, log-logistic).

Usage

```
f_plot_diag_cure_surv_model(PERSUADE, model_index = 1)
```

Arguments

PERSUADE	A PERSUADE object created by f_PERSUADE().
model_index	Integer. Index of the cure model in PERSUADE$surv_pred$model$cure.

Value

A base R diagnostic plot for the selected cure survival model.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = TRUE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_diag_cure_surv_model(PERSUADE, model_index = 1)
```

---

f_plot_diag_param_surv_model

Diagnostic Plot for Parametric Survival Models

Description

Produces diagnostic plots for standard parametric survival models, using appropriate transformations depending on the model family (exponential, Weibull, Gompertz, log-normal, log-logistic, gamma, generalized gamma).

Usage

```
f_plot_diag_param_surv_model(PERSUADE, model_index = 1)
```

Arguments

PERSUADE	A PERSUADE object created by f_PERSUADE().
model_index	Integer. Index of the parametric model in PERSUADE$surv_pred$model.

Value

A base R diagnostic plot for the selected parametric survival model.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_diag_param_surv_model(PERSUADE, model_index = 1)
```

---

f_plot_diag_spline_surv_model

Diagnostic Plot for Spline Survival Models

Description

Produces diagnostic plots for spline-based survival models, using log-time transformations adapted to hazard, odds, or normal scales depending on the spline model type.

Usage

```
f_plot_diag_spline_surv_model(PERSUADE, model_index = 1)
```

Arguments

PERSUADE	A PERSUADE object created by f_PERSUADE().
model_index	Integer. Index of the spline model in PERSUADE$surv_pred$model$spline.

Value

A base R diagnostic plot for the selected spline-based survival model.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = TRUE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_diag_spline_surv_model(PERSUADE, model_index = 1)
```

---

f_plot_hazard_cure_extrap

Plot Extrapolated Hazard Functions (Cure Models)

Description

Plot observed smoothed hazard rates per group and overlay extrapolated hazard functions from all fitted cure survival models (mixture and non-mixture). Runs only when `PERSUADE$input$cure_mod` is `TRUE`.

Usage

```
f_plot_hazard_cure_extrap(PERSUADE)
```

Arguments

`PERSUADE`	A PERSUADE object returned by `f_PERSUADE()`.

Value

Invisibly returns `NULL`. The function draws one or more base R plots as side effects.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
```

```
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = TRUE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_hazard_cure_extrap(PERSUADE)
```

`f_plot_hazard_parametric_extrap` *Plot Extrapolated Hazard Functions (Parametric Models)*

Description

Plot observed smoothed hazard rates per group and overlay extrapolated hazard functions from all fitted parametric survival models.

Usage

```
f_plot_hazard_parametric_extrap(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object returned by `f_PERSUADE()`.

Value

Invisibly returns `NULL`. The function draws one or more base R plots as side effects.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
```

```
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_hazard_parametric_extrap(PERSUADE)
```

`f_plot_hazard_spline_extrap` *Plot Extrapolated Hazard Functions (Spline Models)*

Description

Plot observed smoothed hazard rates per group and overlay extrapolated hazard functions from all fitted spline survival models. Runs only when `PERSUADE$input$spline_mod` is `TRUE`.

Usage

```
f_plot_hazard_spline_extrap(PERSUADE)
```

Arguments

`PERSUADE`	A PERSUADE object returned by `f_PERSUADE()`.

Value

Invisibly returns `NULL`. The function draws one or more base R plots as side effects.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = TRUE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_hazard_spline_extrap(PERSUADE)
```

`f_plot_hazard_with_models` *Hazard Plot with Model Overlays*

Description

Plots observed smoothed hazard estimates together with hazard predictions from parametric, spline, and cure survival models (if fitted).

Usage

```
f_plot_hazard_with_models(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object created by `f_PERSUADE()`.

Value

A series of base R plots, one per group, with hazard overlays by model family.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_hazard_with_models(PERSUADE)
```

`f_plot_km_survival` *Plot Kaplan-Meier Survival Curves (ggsurvplot)*

Description

Generates Kaplan-Meier survival plots from a PERSUADE object using `survminer::ggsurvplot()`, automatically adapting to the number of groups.

Usage

```
f_plot_km_survival(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object created by `f_PERSUADE()`.

Value

A `ggsurvplot` object with KM curves, risk table, CI bands, and optional censor marks.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_km_survival(PERSUADE)
```

f_plot_km_survival_base *Plot Kaplan-Meier Survival Curves (Base R)*

Description

Generates Kaplan-Meier survival plots from a PERSUADE object using base R graphics, with shaded confidence intervals and group-specific legends.

Usage

```
f_plot_km_survival_base(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object created by f_PERSUADE().

Value

A base R plot.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_km_survival_base(PERSUADE)
```

f_plot_log_cumhaz *Log-Log Survival Diagnostic Plot*

Description

Creates a log(-log(S(t))) vs log(time) plot to visually assess proportional hazards.

Usage

```
f_plot_log_cumhaz(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object created by f_PERSUADE().

Value

A base R plot showing ln(-ln(S(t))) against ln(time).

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_log_cumhaz(PERSUADE)
```

`f_plot_param_surv_extrap` *Plot Extrapolated Parametric Survival Models per Group*

Description

Plot Kaplan-Meier curves per group with shaded confidence bands and overlay fitted parametric survival models (Exponential, Weibull, Gompertz, log-normal, log-logistic, Gamma, generalized Gamma) extrapolated to the analysis time horizon.

Usage

```
f_plot_param_surv_extrap(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object returned by `f_PERSUADE()`.

Value

Invisibly returns `NULL`. The function draws one or more base R plots as side effects.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_param_surv_extrap(PERSUADE)
```

f_plot_param_surv_model *Parametric Survival Model Overlay*

Description

Overlays a fitted parametric survival model on top of KM curves, including shaded KM confidence bands per group.

Usage

```
f_plot_param_surv_model(PERSUADE, model_index = 1)
```

Arguments

PERSUADE	A PERSUADE object created by f_PERSUADE().
model_index	Integer. Index of the parametric model in PERSUADE$surv_pred$model.

Value

A base R plot of KM curves with parametric model overlays.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_param_surv_model(PERSUADE, model_index = 1)
```

`f_plot_schoenfeld_residuals` *Schoenfeld Residuals Plot*

Description

Produces scaled Schoenfeld residual plots with fitted regression lines to evaluate Cox proportional hazards assumptions.

Usage

```
f_plot_schoenfeld_residuals(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object created by `f_PERSUADE()`.

Value

One or more base R plots, one per group comparison.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_schoenfeld_residuals(PERSUADE)
```

f_plot_smoothed_hazard *Smoothed Hazard Function Plot*

Description

Plots smoothed hazard estimates for each group in the PERSUADE object.

Usage

```
f_plot_smoothed_hazard(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object created by `f_PERSUADE()`.

Value

A base R plot of smoothed hazards by group.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_smoothed_hazard(PERSUADE)
```

`f_plot_spline_surv_extrap` *Plot Extrapolated Spline Survival Models per Group*

Description

Plot Kaplan-Meier curves per group with shaded confidence bands and overlay fitted spline survival models (hazard, odds, normal scales) extrapolated to the analysis time horizon. Runs only when `PERSUADE$input$spline_mod` is `TRUE`.

Usage

```
f_plot_spline_surv_extrap(PERSUADE)
```

Arguments

`PERSUADE`	A PERSUADE object returned by `f_PERSUADE()`.

Value

Invisibly returns `NULL`. The function draws one or more base R plots as side effects.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = TRUE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_spline_surv_extrap(PERSUADE)
```

f_plot_spline_surv_model *Spline Survival Model Overlay*

Description

Overlays a spline-based survival model on KM curves, including shaded KM confidence bands and vertical lines for knot positions.

Usage

```
f_plot_spline_surv_model(PERSUADE, model_index = 1)
```

Arguments

PERSUADE	A PERSUADE object created by f_PERSUADE().
model_index	Integer. Index of the spline model in PERSUADE$surv_pred$model$spline.

Value

A base R plot of KM curves with spline model overlays and knots.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = TRUE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_spline_surv_model(PERSUADE, model_index = 1)
```

`f_plot_tp_cure_surv_extrap` *Plot Extrapolated Annual Transition Probabilities (Cure Models)*

Description

Plot smoothed observed annual transition probabilities with shaded confidence intervals and overlay predictions from all fitted cure survival models. Runs only when `PERSUADE$input$cure_mod` is `TRUE`.

Usage

```
f_plot_tp_cure_surv_extrap(PERSUADE)
```

Arguments

`PERSUADE`	A PERSUADE object returned by `f_PERSUADE()`.

Value

Invisibly returns `NULL`. The function draws one or more base R plots as side effects.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = TRUE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_tp_cure_surv_extrap(PERSUADE)
```

f_plot_tp_cure_surv_model *Plot Annual Transition Probabilities for Cure Survival Models*

Description

Plot smoothed observed annual transition probabilities with shaded confidence intervals, overlaid with predictions from a selected cure survival model (mixture or non-mixture; Weibull, log-normal, or log-logistic).

Usage

```
f_plot_tp_cure_surv_model(PERSUADE, model_index = 1)
```

Arguments

PERSUADE	A PERSUADE object returned by f_PERSUADE().
model_index	Integer index selecting the cure model within PERSUADE$surv_model$cure_models (1-based). Defaults to 1.

Value

Invisibly returns NULL. The function draws a base R plot as a side effect.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = TRUE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_tp_cure_surv_model(PERSUADE, model_index = 1)
```

`f_plot_tp_param_surv_extrap` *Plot Extrapolated Annual Transition Probabilities (Parametric Models)*

Description

Plot smoothed observed annual transition probabilities with shaded confidence intervals and overlay predictions from all fitted parametric survival models.

Usage

```
f_plot_tp_param_surv_extrap(PERSUADE)
```

Arguments

PERSUADE	A PERSUADE object returned by `f_PERSUADE()`.

Value

Invisibly returns `NULL`. The function draws one or more base R plots as side effects.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_tp_param_surv_extrap(PERSUADE)
```

`f_plot_tp_param_surv_model` *Plot Annual Transition Probabilities for Parametric Survival Models*

Description

Plot smoothed observed annual transition probabilities alongside model-predicted probabilities for a selected parametric model, with shaded confidence intervals per group.

Usage

```
f_plot_tp_param_surv_model(PERSUADE, model_index = 1)
```

Arguments

`PERSUADE`	A PERSUADE object returned by `f_PERSUADE()`.
`model_index`	Integer index selecting the parametric model within `PERSUADE$surv_model$param_models` (1-based). Defaults to `1`.

Value

Invisibly returns `NULL`. The function draws a base R plot as a side effect.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_tp_param_surv_model(PERSUADE, model_index = 1)
```

`f_plot_tp_spline_surv_extrap` *Plot Extrapolated Annual Transition Probabilities (Spline Models)*

Description

Plot smoothed observed annual transition probabilities with shaded confidence intervals and overlay predictions from all fitted spline survival models. Runs only when `PERSUADE$input$spline_mod` is `TRUE`.

Usage

```
f_plot_tp_spline_surv_extrap(PERSUADE)
```

Arguments

`PERSUADE`	A PERSUADE object returned by `f_PERSUADE()`.

Value

Invisibly returns `NULL`. The function draws one or more base R plots as side effects.

See Also

`f_PERSUADE()`

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = TRUE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_tp_spline_surv_extrap(PERSUADE)
```

f_plot_tp_spline_surv_model *Plot Annual Transition Probabilities for Spline Survival Models*

Description

Plot smoothed observed annual transition probabilities together with predictions from a selected spline survival model (hazard/odds/normal scale), including shaded confidence intervals and vertical lines for spline knots.

Usage

```
f_plot_tp_spline_surv_model(PERSUADE, model_index = 1)
```

Arguments

PERSUADE	A PERSUADE object returned by f_PERSUADE().
model_index	Integer index selecting the spline model within PERSUADE$surv_model$spline_models (1-based). Defaults to 1.

Value

Invisibly returns NULL. The function draws a base R plot as a side effect.

See Also

f_PERSUADE()

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = TRUE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
f_plot_tp_spline_surv_model(PERSUADE, model_index = 1)
```

f_summary *Compute Summary Statistics for Numeric Variables*

Description

Compute descriptive statistics for each numeric variable in a data frame: mean, standard deviation, minimum, first quartile (Q1), median, third quartile (Q3), maximum, and interquartile range (IQR). Results are rounded to three decimals.

Usage

```
f_summary(df)
```

Arguments

df	A data frame; numeric columns are summarized.

Value

A data frame (one row per variable) with columns: `Mean`, `Std.Dev`, `Min`, `Q1`, `Median`, `Q3`, `Max`, `IQR`.

Examples

```
f_summary(mtcars)
```

f_surv_model *Fit Parametric Survival Models*

Description

Fits standard parametric models, spline models, and cure models using the **flexsurv** package.

Usage

```
f_surv_model(
  years,
  status,
  group,
  strata,
  ngroups,
  form,
  spline_mod,
  cure_mod,
  cure_link,
  group_names
)
```

Arguments

years	Numeric vector of time-to-event data.
status	Numeric vector indicating event occurrence (1 = event, 0 = censoring).
group	Factor indicating group membership.
strata	Logical. Whether to stratify models by group.
ngroups	Integer. Number of groups.
form	A survival model formula (e.g., `Surv(years, status) ~ group`).
spline_mod	Logical. Whether spline models should be fitted.
cure_mod	Logical. Whether cure models should be fitted.
cure_link	Character string specifying the link function for cure models ("logistic", "loglog", "identity", "probit"; default = "logistic").
group_names	Character vector of group labels (for cure fractions).

Details

Models fitted include Exponential, Weibull, Gompertz, Log-normal, Log-logistic, Gamma, Generalised Gamma. Optional spline models (1-3 knots, scales: hazard, odds, normal) and cure models (Weibull, Log-normal, Log-logistic with logistic/probit/etc. link).

Value

A list containing:

- `param_models`, `param_ic`: Parametric models and information criteria.
- `spline_models`, `spline_ic`: Spline models and IC (if fitted).
- `cure_models`, `cure_ic`: Cure models and IC (if fitted).

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
form <- stats::as.formula(survival::Surv(years, status) ~ group)
f_surv_model(
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  ngroups = nlevels(group),
  form = form,
  spline_mod = FALSE,
  cure_mod = FALSE,
  cure_link = "logistic",
  group_names = levels(group)
)
```

`f_surv_model_excel` *Prepare Excel-Ready Survival Model Output*

Description

Formats model parameters (including spline knots) into a table suitable for export to Excel.

Usage

```
f_surv_model_excel(ngroups, strata, surv_model, spline_mod, cure_mod)
```

Arguments

`ngroups`	Integer. Number of groups.
`strata`	Logical. Whether stratified models were used.
`surv_model`	List of fitted models from `f_surv_model()`.
`spline_mod`	Logical. Whether spline models were included.
`cure_mod`	Logical. Whether cure models were included.

Value

A transposed data frame containing:

- Distribution names
- Parameter names
- Estimates, SE, CI
- Knot values (if splines fitted)
- Covariance matrix

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
form <- stats::as.formula(survival::Surv(years, status) ~ group)
surv_model <- f_surv_model(
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  ngroups = nlevels(group),
  form = form,
  spline_mod = FALSE,
  cure_mod = FALSE,
  cure_link = "logistic",
  group_names = levels(group)
)
f_surv_model_excel(
  ngroups = nlevels(group),
  strata = FALSE,
  surv_model = surv_model,
```

```
  spline_mod = FALSE,
  cure_mod = FALSE
)
```

`f_surv_model_pred` *Predict from Survival Models*

Description

Generates predicted survival and hazard values from fitted parametric, spline, and cure models.

Usage

```
f_surv_model_pred(
  ngroups,
  time_pred,
  surv_model,
  spline_mod,
  cure_mod,
  group_names
)
```

Arguments

`ngroups`	Integer. Number of groups.
`time_pred`	Numeric vector of prediction times.
`surv_model`	List of fitted survival models from `f_surv_model()`.
`spline_mod`	Logical. Whether spline models were fitted.
`cure_mod`	Logical. Whether cure models were fitted.
`group_names`	Character vector of group labels.

Value

A list of predictions containing:

- `param_models`: Survival & hazard predictions for standard models.
- `spline`: Predictions for spline models (if fitted).
- `cure`: Predictions for cure models (if fitted).

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
form <- stats::as.formula(survival::Surv(years, status) ~ group)
surv_model <- f_surv_model(
  years = years,
  status = status,
  group = group,
  strata = FALSE,
```

```
  ngroups = nlevels(group),
  form = form,
  spline_mod = FALSE,
  cure_mod = FALSE,
  cure_link = "logistic",
  group_names = levels(group)
)
f_surv_model_pred(
  ngroups = nlevels(group),
  time_pred = seq(0, 5000, 365.25),
  surv_model = surv_model,
  spline_mod = FALSE,
  cure_mod = FALSE,
  group_names = levels(group)
)
```

`f_surv_model_pred_gr` *Group Predictions by Survival Model*

Description

Consolidates predictions from `f_surv_model_pred()` into group-specific data frames.

Usage

```
f_surv_model_pred_gr(
  ngroups,
  surv_model,
  surv_model_pred,
  spline_mod,
  cure_mod
)
```

Arguments

`ngroups`	Integer. Number of groups.
`surv_model`	List of survival models from `f_surv_model()`.
`surv_model_pred`	List of predictions from `f_surv_model_pred()`.
`spline_mod`	Logical. Whether spline models were fitted.
`cure_mod`	Logical. Whether cure models were fitted.

Value

A list of length `ngroups`, each a data frame with columns:

- `time`
- survival predictions for all models (parametric, spline, cure).

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
form <- stats::as.formula(survival::Surv(years, status) ~ group)
surv_model <- f_surv_model(
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  ngroups = nlevels(group),
  form = form,
  spline_mod = FALSE,
  cure_mod = FALSE,
  cure_link = "logistic",
  group_names = levels(group)
)
surv_model_pred <- f_surv_model_pred(
  ngroups = nlevels(group),
  time_pred = seq(0, 5000, 365.25),
  surv_model = surv_model,
  spline_mod = FALSE,
  cure_mod = FALSE,
  group_names = levels(group)
)
f_surv_model_pred_gr(
  ngroups = nlevels(group),
  surv_model = surv_model,
  surv_model_pred = surv_model_pred,
  spline_mod = FALSE,
  cure_mod = FALSE
)
```

---

f_surv_model_pred_tp_gr

Compute Transition Probabilities for Survival Model Predictions

---

Description

Compute Transition Probabilities for Survival Model Predictions

Usage

```
f_surv_model_pred_tp_gr(
  ngroups,
  time_pred,
  time_unit,
  surv_model_pred_gr,
  cols_tp
)
```

Arguments

ngroups	Integer, number of groups.
time_pred	Numeric vector of prediction times (currently unused).
time_unit	Numeric, time unit for transition probability calculation.
surv_model_pred_gr	List of group predictions. Each group's table should have a time column in column 1 and survival-related columns from 2:cols_tp.
cols_tp	Integer, index of the last survival-related column (i.e., use columns 2:cols_tp).

Value

Named list of data.frames with transition probabilities (truncated after threshold).

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
form <- stats::as.formula(survival::Surv(years, status) ~ group)
surv_model <- f_surv_model(
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  ngroups = nlevels(group),
  form = form,
  spline_mod = FALSE,
  cure_mod = FALSE,
  cure_link = "logistic",
  group_names = levels(group)
)
surv_model_pred <- f_surv_model_pred(
  ngroups = nlevels(group),
  time_pred = seq(0, 5000, 365.25),
  surv_model = surv_model,
  spline_mod = FALSE,
  cure_mod = FALSE,
  group_names = levels(group)
)
surv_model_pred_gr <- f_surv_model_pred_gr(
  ngroups = nlevels(group),
  surv_model = surv_model,
  surv_model_pred = surv_model_pred,
  spline_mod = FALSE,
  cure_mod = FALSE
)
f_surv_model_pred_tp_gr(
  ngroups = nlevels(group),
  time_pred = seq(0, 5000, 365.25),
  time_unit = 365.25/12,
  surv_model_pred_gr = surv_model_pred_gr,
  cols_tp = 8
)
```

f_tp *Calculate Transition Probabilities*

Description

Derives annualized transition probabilities (and confidence bounds) from cumulative hazard estimates, smoothed with LOESS.

Usage

```
f_tp(ngroups, cum_haz, time_unit)
```

Arguments

ngroups	Integer. Number of groups (1-3).
cum_haz	Data frame from f_cum_hazard() with columns group, time, H_delta, H_upper_delta, H_lower_delta.
time_unit	Numeric. Time unit for annualization.

Value

A list with:

- gr_1, gr_2, gr_3: Data frames of smoothed probabilities per group.
- max: Maximum upper bound across all groups.

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
cum_haz <- f_cum_hazard(
  years = years,
  status = status,
  group = group,
  ngroups = nlevels(group),
  time_pred = seq(0, 5000, 365.25),
  time_unit = 30
)
f_tp(ngroups = nlevels(group), cum_haz = cum_haz, time_unit = 30)
```

`plot.PERSUADE` *Plot Method for PERSUADE Objects*

Description

Generates diagnostic and model fit plots for PERSUADE survival analysis objects. The `type` argument controls which plot(s) are produced:

- `"km"`: Kaplan-Meier survival curves.
- `"ph"`: Proportional hazards diagnostics.
- `"hr"`: Hazard function with fitted models.
- `"param_models"`: Fitted parametric survival models with diagnostics and transition probability plots.
- `"spline_models"`: Fitted spline-based survival models with diagnostics and transition probability plots.
- `"cure_models"`: Fitted cure survival models with diagnostics and transition probability plots.

Usage

```
## S3 method for class 'PERSUADE'
plot(x, type = "km", ...)
```

Arguments

`x`	A PERSUADE object from `f_PERSUADE()`.
`type`	Character. The type of plot to produce.
`...`	Additional arguments (currently unused).

Value

Invisibly returns a list of results from the plotting functions. Also produces base R plots as side effects.

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
plot(PERSUADE, "km")
```

print.PERSUADE *Print Method for PERSUADE Objects*

Description

Displays a brief summary of the PERSUADE object in the console.

Usage

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

Arguments

x	A PERSUADE object from f_PERSUADE().
...	Additional arguments (currently unused).

Value

Invisibly returns the PERSUADE object.

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
print(PERSUADE)
```

summary.PERSUADE *Summary Method for PERSUADE Objects*

Description

The type argument controls which summary is produced:

- "km": Kaplan-Meier estimates (default).
- "surv_probs": Survival probabilities at specified prediction times for each group.
- "gof": Goodness-of-fit statistics for standard parametric models.
- "gof_spline": Goodness-of-fit statistics for spline models.
- "gof_cure": Goodness-of-fit statistics for cure models (including cure fraction).

Usage

```
## S3 method for class 'PERSUADE'
summary(object, ..., type = "km")
```

Arguments

object	A PERSUADE object from f_PERSUADE().
...	Additional arguments. Currently only type is used.
type	Character string, one of "km", "surv_probs", "gof", "gof_spline", "gof_cure". Controls the type of summary output.

Value

A data frame or list of data frames depending on type.

Examples

```
years <- survival::lung$time
status <-  survival::lung$status
group <- factor(survival::lung$sex)
PERSUADE <- f_PERSUADE(
  name = "Example",
  years = years,
  status = status,
  group = group,
  strata = FALSE,
  spline_mod = FALSE,
  cure_mod = FALSE,
  time_unit = 365.25/12,
  time_horizon = 2000,
  time_pred_surv_table = seq(0, 2000, 365.25)
)
summary(PERSUADE, type = "surv_probs")
```

Index