Package 'PERSUADE'

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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)

URL https://github.com/Bram-R/PERSUADE

BugReports https://github.com/Bram-R/PERSUADE/issues

Depends R (>= 4.1.0)

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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