

Package ‘cmpp’

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Type Package

Title Parametric Methods for Cumulative Incidence Functions in
Competing Risks

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Description

Implements parametric modeling and regression methods for cumulative incidence functions in the presence of competing risks. Methods include the direct Gompertz-based approach and generalized regression models as described in Jeong and Fine (2006, 2007). The package facilitates maximum likelihood estimation, variance computation, and goodness-of-fit evaluation for competing risks data, with applications to clinical trials and survival analysis.

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bootstrap_variance	<i>Estimate Variance of Parameters Using Bootstrap Method</i>
--------------------	---

Description

This function estimates the variance of model parameters using the bootstrap method. It repeatedly samples the data with replacement, estimates the parameters for each sample, and computes the variance of the estimated parameters.

Usage

```
bootstrap_variance(features, x, delta1, delta2, initial_params, n_bootstrap, optimMethod)
```

Arguments

features	A numeric matrix of predictor variables. Each row corresponds to an observation.
x	A numeric vector of failure times corresponding to observations.
delta1	A binary vector indicating the occurrence of the first competing event (1 for observed).

delta2 A binary vector indicating the occurrence of the second event (1 for observed).
initial_params A numeric vector of initial parameter values to start the optimization.
n_bootstrap An integer specifying the number of bootstrap samples.
optimMethod A character string specifying the optimization method to use. Default is "BFGS".

Details

This function performs bootstrap sampling to estimate the variance of the model parameters. It requires the data to be initialized using `Initialize` before being called.

Value

A list containing:

- **variances**: A numeric vector representing the variance of the estimated parameters.
- **bootstrap_estimates**: A matrix of parameter estimates for each bootstrap sample.

Examples

```
## Not run:
features <- matrix(rnorm(100), ncol = 5)
x <- rnorm(20)
delta1 <- sample(0:1, 20, replace = TRUE)
delta2 <- sample(0:1, 20, replace = TRUE)
initial_params <- c(0.01, 0.01, 0.01, 0.01)
n_bootstrap <- 1000
results <- bootstrap_variance(features, x, delta1, delta2, initial_params, n_bootstrap)
print(results$variances)
print(results$bootstrap_estimates)

## End(Not run)
```

cdf_gomp

Compute the CDF of the Gompertz Distribution

Description

Calculates the cumulative distribution function (CDF) of the Gompertz distribution for given input values and parameters.

Usage

```
cdf_gomp(x, alpha, beta)
```

Arguments

x A numeric vector of non-negative input values (e.g., failure times).
alpha A positive numeric value representing the shape parameter.
beta A positive numeric value representing the scale parameter.

Details

The Gompertz distribution is commonly used in survival analysis and reliability studies. Ensure that alpha and beta are positive for meaningful results.

Value

A numeric vector of the CDF values for each input in x.

Examples

```
## Not run:
x <- c(1, 2, 3)
alpha <- 0.5
beta <- 0.1
cdf_gomp(x, alpha, beta)

## End(Not run)
```

CIF_Figs

Plot Cumulative Incidence Functions (CIF) with Confidence Intervals

Description

This function plots the cumulative incidence functions (CIF) for two competing risks based on the estimated parameters and their variances. It includes confidence intervals for the CIFs.

Usage

```
CIF_Figs(initial_params, TimeFailure, OrderType = c(2, 1), RiskNames = NULL)
```

Arguments

<code>initial_params</code>	A numeric vector of initial parameter values to start the optimization.
<code>TimeFailure</code>	A numeric vector of failure times corresponding to observations.
<code>OrderType</code>	A numeric vector indicating the order of the competing risks. Default is c(2, 1).
<code>RiskNames</code>	A character vector of names for the competing risks. Default is NULL.

Details

This function performs the following steps:

- Estimates the model parameters using the `estimate_parameters` function.
- Computes the Hessian matrix using the `compute_hessian` function.
- Ensures that the diagonal elements of the covariance matrix are positive.
- Computes the cumulative incidence functions (CIF) for two competing risks.
- Plots the CIFs along with their confidence intervals.

Value

A ggplot object showing the CIFs and their confidence intervals.

Examples

```
## Not run:
initial_params <- c(0.01, 0.01, 0.01, 0.01)
TimeFailure <- seq(0, 10, by = 0.1)
plot <- CIF_Figs(initial_params, TimeFailure)
print(plot)

## End(Not run)
```

CIF_res1

*Compute Cumulative Incidence Function (CIF) Results***Description**

This function estimates the parameters of the model, computes the Hessian matrix, and calculates the variances and p-values for the parameters. It ensures that the diagonal elements of the covariance matrix are positive.

Usage

```
CIF_res1(initial_params = rep(0.001, 4))
```

Arguments

initial_params A numeric vector of initial parameter values to start the optimization. Default is `rep(0.001, 4)`.

Details

This function performs the following steps:

- Estimates the model parameters using the `estimate_parameters` function.
- Computes the Hessian matrix using the `compute_hessian` function.
- Ensures that the diagonal elements of the covariance matrix are positive.
- Calculates the variances and p-values for the parameters.

Value

A data frame containing:

Params	The parameter names ("alpha1", "beta1", "alpha2", "beta2").
STD	The standard deviations of the parameters.

Examples

```
## Not run:
initial_params <- c(0.001, 0.001, 0.001, 0.001)
result <- CIF_res1(initial_params)
print(result)

## End(Not run)
```

Cleanup

Clean up memory by deleting the pointer to the Cmpp instance

Description

This function is used to clean up and delete the instance of the Cmpp class in the C++ code. It ensures proper memory management and prevents memory leaks by deleting the pointer to the Cmpp object when it is no longer needed. It is important to call this function after you are done with the Cmpp object to ensure that no memory is leaked.

Usage

```
Cleanup()
```

Details

The Cleanup function must be called after using the Cmpp object to clean up the allocated memory in C++. Failure to call this function may result in memory leaks, as the memory allocated for the Cmpp object is not automatically freed.

Examples

```
## Not run:
# Assuming you have previously initialized the Cmpp object with `Initialize()`
Cleanup()

## End(Not run)
```

cmpp

Parametric (Direct) Methods for Cumulative Incidence Functions in Competing Risks

Description

The cmpp package provides parametric (Direct) modeling methods for analyzing cumulative incidence functions (CIFs) in the context of competing risks. It includes Gompertz-based models, regression techniques, and parametric (Direct) approaches such as the Generalized Chance Model (GCM), Proportional Odds Model (POM), and Proportional Hazards Model (PHM). The package enables users to estimate and compare CIFs using maximum likelihood estimation, perform regression analysis, and visualize CIFs with confidence intervals. It also supports covariate adjustment and bootstrap variance estimation.

Details

The cmpp package offers functions for modeling cumulative incidence functions (CIFs) Directly using the Gompertz distribution and generalized regression models.

Key features include:

- Direct parametric modeling for cumulative incidence functions.
- Maximum likelihood estimation of parameters.

- Regression analysis with covariates, including treatment effects.
- Visualization of CIFs with confidence intervals.
- Covariate-adjusted CIF estimation.
- Bootstrap variance estimation for model parameters.

Commonly used functions include:

- [Initialize](#): Initializes the data for the Cmpp model.
- [LogLike1](#): Computes the negative log-likelihood for the model without covariate effect.
- [compute_grad](#): Computes the gradient of the log-likelihood.
- [compute_hessian](#): Computes the Hessian matrix of the log-likelihood.
- [estimate_parameters_GCM](#): Estimates parameters using the Generalized Chance Model (GCM).
- [estimate_parameters_POM](#): Estimates parameters using the Proportional Odds Model (POM).
- [estimate_parameters_PHM](#): Estimates parameters using the Proportional Hazards Model (PHM).
- [CIF_res1](#): Computes CIF results for competing risks without covariates.
- [CIF_Figs](#): Plots CIFs with confidence intervals (without covariate effect).
- [Cmpp_CIF](#): Computes and plots CIFs for competing risks using GCM, POM, and PHM.
- [FineGray_Model](#): Fits a Fine-Gray regression model for competing risks data and visualize CIF by Fine-Gray model result using [cmprsk::cuminc](#) and [cmprsk::crr](#).
- [bootstrap_variance](#): Estimates variance of parameters using the bootstrap method.
- [GetData](#): Retrieves initialized data from the Cmpp model.
- [Cleanup](#): Cleans up memory by deleting the Cmpp instance.

Author(s)

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References

- Jeong, J.-H., & Fine, J. (2006). Direct parametric inference for the cumulative incidence function. *Applied Statistics*, 55(2), 187-200.
- Jeong, J.-H., & Fine, J. (2007). Parametric regression on cumulative incidence function. *Bio-statistics*, 8(2), 184-196.

See Also

[Initialize](#), [LogLike1](#), [compute_grad](#), [compute_hessian](#), [estimate_parameters_GCM](#), [estimate_parameters_POM](#), [estimate_parameters_PHM](#), [CIF_res1](#), [CIF_Figs](#), [Cmpp_CIF](#), [FineGray_Model](#), [bootstrap_variance](#), [GetData](#), [Cleanup](#)

Examples

```
## Not run:
## Example: Initialize the Cmpp model and compute CIFs
library(cmpp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100, replace = TRUE)
delta2 <- 1 - delta1
timee <- rexp(100, rate = 1/10)

Initialize(features, timee, delta1, delta2, h = 1e-5)
# Initialize the Cmpp model

# Estimate parameters using the Generalized Chance Model (GCM)
initial_params <- rep(0.001, 2 * (ncol(features) + 3))
result <- estimate_parameters_GCM(initial_params)
print(result)

# Compute CIFs for competing risks (without covariate effect | Not Regression model)
cif_results <- CIF_res1(initial_params)
print(cif_results)

# Plot CIFs with confidence intervals
plot <- CIF_Figs(initial_params, timee)
print(plot)

# Compute and plot adjusted CIFs
result_cif <- Cmpp_CIF(
  featureID = c(1, 2),
  featureValue = c(0.5, 1.2),
  RiskNames = c("Event1", "Event2"),
  TypeMethod = "GCM",
  predTime = seq(0, 10, by = 0.5)
)
print(result_cif$Plot$Plot_InputModel) # Plot for the specified model
print(result_cif$CIF$CIFAdjusted) # Adjusted CIF values

# Fit a Fine-Gray model for competing risks
result_fg <- FineGray_Model(
  featureNames = c("Feature1", "Feature2"),
  CovarNames = c("Covar1", "Covar2"),
  Failcode = 1,
  RiskNames = c("Event1", "Event2")
)
print(result_fg$Results) # Summary of the Fine-Gray model
print(result_fg$Plot) # Plot of the CIFs

# Clean up memory
Cleanup()

## End(Not run)
```


Description

This function computes and plots the cumulative incidence functions (CIF) for competing risks using three parametric models: Generalized Chance Model (GCM), Proportional Odds Model (POM), and Proportional Hazards Model (PHM). It allows for adjusted CIFs based on specific covariate values and provides visualizations for all models.

Usage

```
Cmpp_CIF(
  featureID = NULL,
  featureValue = NULL,
  RiskNames = NULL,
  TypeMethod = "GCM",
  predTime = NULL
)
```

Arguments

featureID	A numeric vector of indices specifying the features to adjust. Default is NULL.
featureValue	A numeric vector of values corresponding to the features specified in featureID. Default is NULL.
RiskNames	A character vector specifying the names of the competing risks. Default is NULL, which assigns names as "Risk1" and "Risk2".
TypeMethod	A character string specifying the model to use for plotting. Must be one of "GCM", "POM", or "PHM". Default is "GCM".
predTime	A numeric vector of time points for which CIFs are computed. Default is NULL, which uses the failure times from the initialized data.

Details

This function performs the following steps:

- Estimates the model parameters for GCM, POM, and PHM using the `estimate_parameters_GCM`, `estimate_parameters_POM`, and `estimate_parameters_PHM` functions.
- Computes the CIFs for the specified time points and covariate values.
- Generates plots for the CIFs, including adjusted CIFs based on specific covariate values.
- Provides separate plots for each model and a combined plot for all models.

If `featureID` and `featureValue` are provided, the function adjusts the CIFs based on the specified covariate values. If `RiskNames` is not provided, the default names "Risk1" and "Risk2" are used. The `TypeMethod` parameter determines which model's CIF plot is returned in the output.

Value

A list containing:

Time	A list with the input time points, time points for adjusted plots, and time points for null plots.
CIF	A list with the following elements: <ul style="list-style-type: none"> • CIFNULL: A data frame containing the CIFs for the null model (not adjusted by covariates).

- CIFAdjusted: A data frame containing the CIFs adjusted by covariates.
- Plot
- A list with the following elements:
- PlotNull_AllModels: A ggplot object showing the CIFs for all models (not adjusted by covariates).
 - PlotAdjusted_AllModels: A ggplot object showing the adjusted CIFs for all models.
 - Plot_InputModel: A ggplot object showing the CIFs for the specified model (TypeMethod).

Examples

```
## Not run:
# Assuming the Cmpp model has been initialized
result <- Cmpp_CIF(
  featureID = c(1, 2),
  featureValue = c(0.5, 1.2),
  RiskNames = c("Event1", "Event2"),
  TypeMethod = "GCM",
  predTime = seq(0, 10, by = 0.5)
)
print(result$Plot$Plot_InputModel) # Plot for the specified model
print(result$Plot$PlotAdjusted_AllModels) # Adjusted CIFs for all models
print(result$CIF$CIFAdjusted) # Adjusted CIF values

## End(Not run)
```

compute_grad

Compute the Numerical Gradient of the Log-Likelihood

Description

Calculates the gradient of the negative log-likelihood using finite differences. The function uses a small step size (h) defined during initialization.

Usage

```
compute_grad(param)
```

Arguments

param A numeric vector of parameters for which the gradient is calculated.

Details

This function approximates the gradient using central finite differences. Ensure that h is appropriately set to avoid numerical instability.

Value

A numeric vector of the same length as param, representing the gradient at the specified parameters.

Examples

```
## Not run:
param <- c(0.5, 0.1, 0.6, 0.2)
compute_grad(param)

## End(Not run)
```

`compute_hessian`*Compute the Hessian Matrix of the Log-Likelihood*

Description

Calculates the Hessian matrix of the negative log-likelihood function using finite differences. This function is useful for understanding the curvature of the log-likelihood surface and for optimization purposes.

Usage

```
compute_hessian(param)
```

Arguments

`param` A numeric vector of parameters for which the Hessian matrix is calculated.

Details

This function approximates the Hessian matrix using central finite differences. Ensure that the step size `h` is appropriately set during initialization to avoid numerical instability. The function requires the data to be initialized using `Initialize` before being called.

Value

A numeric matrix representing the Hessian matrix at the specified parameters.

Examples

```
## Not run:
param <- c(0.5, 0.1, 0.6, 0.2)
hessian <- compute_hessian(param)
print(hessian)

## End(Not run)
```

```
compute_log_f_gradient_rcpp
```

*Compute the Gradient of the Log-Likelihood Function Generalized
Chance Model (GCM)*

Description

This function computes the gradient of the log-likelihood function for the parametric model (GCM Approach).

Arguments

Params A numeric vector of parameters.

Value

A numeric vector representing the gradient of the log-likelihood.

Examples

```
## Not run:
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 3))
gradient <- compute_log_f_gradient_rcpp(params)
print(gradient)

## End(Not run)
```

```
compute_log_f_gradient_rcpp2
```

*Compute the Gradient of the Log-Likelihood Function Proportional
Odds Model (POM)*

Description

This function computes the gradient of the log-likelihood function for the parametric model (POM Approach).

Arguments

Params A numeric vector of parameters.

Value

A numeric vector representing the gradient of the log-likelihood.

Examples

```
## Not run:
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 2))
gradient <- compute_log_f_gradient_rcpp2(params)
print(gradient)

## End(Not run)
```

```
compute_log_f_gradient_rcpp3
```

Compute the Gradient of the Log-Likelihood Function Proportional Hazards Model (PHM)

Description

This function computes the gradient of the log-likelihood function for the parametric model (PHM Approach).

Arguments

Params A numeric vector of parameters.

Value

A numeric vector representing the gradient of the log-likelihood.

Examples

```
## Not run:
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 2))
gradient <- compute_log_f_gradient_rcpp2(params)
print(gradient)

## End(Not run)
```

```
compute_log_f_hessian_rcpp
```

Compute the Hessian Matrix of the Log-Likelihood Function Generalized Chance Model (GCM)

Description

This function computes the Hessian matrix of the log-likelihood function for the parametric model (GCM Approach).

Arguments

Params A numeric vector of parameters.

Value

A numeric matrix representing the Hessian matrix of the log-likelihood.

Examples

```
## Not run:
library(cmp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 3))
hessian <- compute_log_f_hessian_rcpp(params)
print(hessian)

## End(Not run)
```

```
dat
```

Example Dataset: dat

Description

This dataset contains survival data for a study involving burn injuries.

Usage

```
dat
```

Format

A data frame with 968 rows and 21 variables:

id Unique identifier for each individual.

time Time to event or censoring.

event Event indicator Variable:, 3 = event occurred (Discharge), 1 = Cardio Arrest (Competing Risk), 2 = Sepsis (Main Event).

age Age of the individual.

sex Sex of the individual (e.g., "Male", "Female").

percent_burn Percentage of body burned.

cause_burn Cause of burn (e.g., "Fire", "Hot Object").

ca Calcium levels.

k Potassium levels.

mg Magnesium levels.

na Sodium levels.

pho Phosphorus levels.

alb Albumin levels.

bun Blood urea nitrogen levels.

cr Creatinine levels.

wbc White blood cell count.

d1 A Indicator variable to indicate the cause of death, which takes the value 1 if death is due to Sepsis and the value zero otherwise.

d2 A Indicator variable to indicate the cause of death, which takes the value 1 if death was due to a Cardio Arrest, and the value 0 otherwise.

cause_fire1 Indicator for burns caused by fire.

cause_boiling2 Indicator for burns caused by boiling liquids.

cause_hotObject3 Indicator for burns caused by hot objects.

Source

real-world dataset from a study on burn injuries (Shiraz Accident and Burn Hospital, Iran).

estimate_parameters	<i>Estimate Model Parameters Using Optimization</i>
---------------------	---

Description

This function estimates the parameters of a model by minimizing the negative log-likelihood function using the specified optimization method. It utilizes the `optim()` function in R, with the provided initial parameter values and gradient computation. The optimization method can be specified, with "BFGS" being the default.

Usage

```
estimate_parameters(initial_params = rep(0.01, 4), optimMethod = 'BFGS')
```

Arguments

- `initial_params` A numeric vector of initial parameter values to start the optimization. Default is a vector of four values, all set to 0.01.
- `optimMethod` A character string specifying the optimization method to use. The default is "BFGS". See `?optim` for a list of available methods.

Details

The `estimate_parameters` function performs parameter estimation by minimizing the negative log-likelihood function using the chosen optimization method. The function requires an initial guess for the parameters (a numeric vector) and will optimize the log-likelihood function. The optimization also takes into account the gradient of the log-likelihood function, which is computed using the `compute_grad` function. The result of the optimization is an object of class `optim` containing the estimated parameters and other details of the optimization process.

The optimization method can be specified via the `optimMethod` argument. The default method is "BFGS", but any method supported by R's `optim()` function (such as "Nelder-Mead", "CG", etc.) can be used.

Value

An `optim` object containing the optimization results, including the estimated parameters, value of the objective function at the optimum, and other optimization details.

See Also

[stats::optim](#) for more details on optimization methods and usage.

Examples

```
## Not run:
# Estimate model parameters using default initial values and the BFGS method
result <- estimate_parameters()
print(result)

## End(Not run)
```

estimate_parameters_GCM

Estimate Parameters for the Generalized Chance Model (GCM)

Description

This function estimates the parameters of the Generalized Chance Model (GCM) using maximum likelihood estimation. It computes the Hessian matrix, calculates standard errors, and derives p-values for the estimated parameters. The function ensures that the diagonal elements of the covariance matrix are positive for valid variance estimates.

Usage

```
estimate_parameters_GCM(initial_params, FeaturesNames = NULL)
```


Arguments

- initial_params** A numeric vector of initial parameter values to start the optimization. Default is `rep(0.001, 2 * (3 + ncol(features)))`, where `features` is the matrix of predictor variables.
- FeaturesNames** A character vector specifying the names of the features (covariates). If `NULL`, default names (`beta1`, `beta2`, etc.) will be generated.

Details

This function performs the following steps:

- Estimates the model parameters using the `optim` function with the BFGS method.
- Computes the gradient of the log-likelihood using the `compute_log_f_gradient_rcpp` function.
- Computes the Hessian matrix numerically using the `hessian` function from the `numDeriv` package.
- Ensures that the diagonal elements of the covariance matrix are positive to avoid invalid variance estimates.
- Calculates standard errors and p-values for the estimated parameters.

The Generalized Chance Model (GCM) is a parametric model for cumulative incidence functions in competing risks analysis. It uses Gompertz distributions to model the failure times for competing events.

Value

A data frame containing:

Parameter	The parameter names, including <code>alpha1</code> , <code>tau1</code> , <code>rho1</code> , <code>alpha2</code> , <code>tau2</code> , <code>rho2</code> , and covariate coefficients (<code>beta1</code> , <code>beta2</code> , etc.).
Estimate	The estimated parameter values.
S.E	The standard errors of the estimated parameters.
PValue	The p-values for the estimated parameters.

See Also

[stats::optim](#), [compute_log_f_gradient_rcpp](#), [log_f_rcpp](#), [compute_log_f_hessian_rcpp](#).

Examples

```
## Not run:
library(cmp)
# Example data
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100, replace = TRUE)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)

# Initialize the Cmp model
Initialize(features, x, delta1, delta2, h = 1e-5)

# Define initial parameter values
```

```

initial_params <- rep(0.001, 2 * (ncol(features) + 3))

# Estimate parameters using the GCM
result <- estimate_parameters_GCM(initial_params)
print(result)

## End(Not run)

```

estimate_parameters_PHM

Estimate Parameters for the Proportional Hazards Model (PHM)

Description

This function estimates the parameters of the Proportional Hazards Model (PHM) using maximum likelihood estimation. It computes the Hessian matrix, calculates standard errors, and derives p-values for the estimated parameters. The function ensures that the diagonal elements of the covariance matrix are positive for valid variance estimates.

Usage

```
estimate_parameters_PHM(initial_params, FeaturesNames = NULL)
```

Arguments

initial_params A numeric vector of initial parameter values to start the optimization. Default is `rep(0.001, 2 * (2 + ncol(features)))`, where `features` is the matrix of predictor variables.

FeaturesNames A character vector specifying the names of the features (covariates). If `NULL`, default names (`beta1`, `beta2`, etc.) will be generated.

Details

This function performs the following steps:

- Estimates the model parameters using the `optim` function with the BFGS method.
- Computes the gradient of the log-likelihood using the `compute_log_f_gradient_rcpp3` function.
- Computes the Hessian matrix numerically using the `hessian` function from the `numDeriv` package.
- Ensures that the diagonal elements of the covariance matrix are positive to avoid invalid variance estimates.
- Calculates standard errors and p-values for the estimated parameters.

The Proportional Hazards Model (PHM) is a parametric model for cumulative incidence functions in competing risks analysis. It uses Gompertz distributions to model the failure times for competing events.

Value

A data frame containing:

Parameter	The parameter names, including tau1, rho1, tau2, rho2, and covariate coefficients (beta1, beta2, etc.).
Estimate	The estimated parameter values.
S.E	The standard errors of the estimated parameters.
PValue	The p-values for the estimated parameters.

See Also

[stats::optim](#), [compute_log_f_gradient_rcpp3](#), [log_f_rcpp3](#).

Examples

```
## Not run:
library(cmp)
# Example data
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100, replace = TRUE)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)

# Initialize the Cmp model
Initialize(features, x, delta1, delta2, h = 1e-5)

# Define initial parameter values
initial_params <- rep(0.001, 2 * (ncol(features) + 2))

# Estimate parameters using the PHM
result <- estimate_parameters_POM(initial_params)
print(result)

## End(Not run)
```

estimate_parameters_POM

Estimate Parameters for the Proportional Odds Model (POM)

Description

This function estimates the parameters of the Proportional Odds Model (POM) using maximum likelihood estimation. It computes the Hessian matrix, calculates standard errors, and derives p-values for the estimated parameters. The function ensures that the diagonal elements of the covariance matrix are positive for valid variance estimates.

Usage

```
estimate_parameters_POM(initial_params, FeaturesNames = NULL)
```

Arguments

- initial_params** A numeric vector of initial parameter values to start the optimization. Default is `rep(0.001, 2 * (2 + ncol(features)))`, where `features` is the matrix of predictor variables.
- FeaturesNames** A character vector specifying the names of the features (covariates). If `NULL`, default names (`beta1`, `beta2`, etc.) will be generated.

Details

This function performs the following steps:

- Estimates the model parameters using the `optim` function with the BFGS method.
- Computes the gradient of the log-likelihood using the `compute_log_f_gradient_rcpp2` function.
- Computes the Hessian matrix numerically using the `hessian` function from the `numDeriv` package.
- Ensures that the diagonal elements of the covariance matrix are positive to avoid invalid variance estimates.
- Calculates standard errors and p-values for the estimated parameters.

The Proportional Odds Model (POM) is a parametric model for cumulative incidence functions in competing risks analysis. It uses Gompertz distributions to model the failure times for competing events.

Value

A data frame containing:

Parameter	The parameter names, including <code>tau1</code> , <code>rho1</code> , <code>tau2</code> , <code>rho2</code> , and covariate coefficients (<code>beta1</code> , <code>beta2</code> , etc.).
Estimate	The estimated parameter values.
S.E	The standard errors of the estimated parameters.
PValue	The p-values for the estimated parameters.

See Also

[stats::optim](#), [compute_log_f_gradient_rcpp2](#), [log_f_rcpp2](#).

Examples

```
## Not run:
library(cmp)
# Example data
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100, replace = TRUE)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)

# Initialize the Cmp model
Initialize(features, x, delta1, delta2, h = 1e-5)

# Define initial parameter values
```

```

initial_params <- rep(0.001, 2 * (ncol(features) + 2))

# Estimate parameters using the POM
result <- estimate_parameters_POM(initial_params)
print(result)

## End(Not run)

```

FineGray_Model

Fine-Gray Model for Competing Risks Data

Description

This function fits a Fine-Gray model for competing risks data using the `cmprsk` package. It estimates the subdistribution hazard model parameters, computes cumulative incidence functions (CIFs), and provides a summary of the results along with a plot of the CIFs.

Usage

```

FineGray_Model(
  featureNames = NULL,
  CovarNames = NULL,
  Failcode = 1,
  RiskNames = NULL
)

```

Arguments

<code>featureNames</code>	A character vector of feature names for the covariates. If <code>NULL</code> , default names will be generated.
<code>CovarNames</code>	A character vector of names for the covariates. If <code>NULL</code> , default names will be generated.
<code>Failcode</code>	An integer specifying the event of interest (default is 1).
<code>RiskNames</code>	A character vector specifying the names of the competing risks. If <code>NULL</code> , default names ("Risk1" and "Risk2") will be used.

Details

This function retrieves the data initialized in the `Cmpp` model using the `GetData` function. It uses the `crr` function from the `cmprsk` package to fit the Fine-Gray model for competing risks. The function also computes cumulative incidence functions (CIFs) using the `cuminc` function and generates a plot of the CIFs for the competing risks.

Value

A list containing:

<code>Results</code>	A summary of the Fine-Gray model fit.
<code>Plot</code>	A ggplot object showing the cumulative incidence functions (CIFs) for the competing risks.
<code>CIF_Results</code>	A data frame containing the CIFs for the competing risks, along with their corresponding time points.

Examples

```
## Not run:
# Assuming the Cmpp model has been initialized
result <- FineGray_Model(
  featureNames = c("Feature1", "Feature2"),
  CovarNames = c("Covar1", "Covar2"),
  Failcode = 1,
  RiskNames = c("Event1", "Event2")
)
print(result$Results) # Summary of the Fine-Gray model
print(result$Plot)    # Plot of the CIFs
print(result$CIF_Results) # CIF data

## End(Not run)
```

F_cdf_rcpp

Compute the CDF of the Parametric Generalized Chance Model (GCM)

Description

This function computes the cumulative distribution function (CDF) of the parametric model (GCM Approach).

Arguments

Params	A numeric vector of parameters.
Z	A numeric vector of covariates.
x	A numeric value representing the time point.

Value

A numeric value representing the CDF.

Examples

```
## Not run:
library(cmpp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 3))
x <- 5
cdf_value <- F_cdf_rcpp(params, features[1, ], x)
print(cdf_value)

## End(Not run)
```

F_cdf_rcpp2

*Compute the CDF of the Parametric Proportional Odds Model (POM)***Description**

This function computes the cumulative distribution function (CDF) of the parametric model (POM Approach).

Arguments

Params	A numeric vector of parameters.
Z	A numeric vector of covariates.
x	A numeric value representing the time point.

Value

A numeric value representing the CDF.

Examples

```
## Not run:
library(cmp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 2))
x <- 5
cdf_value <- F_cdf_rcpp2(params, features[1, ], x)
print(cdf_value)

## End(Not run)
```

F_cdf_rcpp3

*Compute the CDF of the Parametric Proportional Hazards Model (PHM)***Description**

This function computes the cumulative distribution function (CDF) of the parametric model (PHM Approach).

Arguments

Params	A numeric vector of parameters.
Z	A numeric vector of covariates.
x	A numeric value representing the time point.

Value

A numeric value representing the CDF.

Examples

```
## Not run:
library(cmp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 2))
x <- 5
cdf_value <- F_cdf_rcpp2(params, features[1, ], x)
print(cdf_value)

## End(Not run)
```

f_pdf_rcpp

Compute the PDF of the Parametric Generalized Chance Model (GCM)

Description

This function computes the probability density function (PDF) of the parametric model (GCM Approach).

Arguments

Params	A numeric vector of parameters.
Z	A numeric vector of covariates.
x	A numeric value representing the time point.

Value

A numeric value representing the PDF.

Examples

```
## Not run:
library(cmp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 3))
pdf_value <- f_pdf_rcpp(params, Z[1, ], x[3])
print(pdf_value)

## End(Not run)
```


f_pdf_rcpp2

*Compute the PDF of the Parametric Proportional Odds Model (POM)***Description**

This function computes the probability density function (PDF) of the parametric model (POM Approach).

Arguments

Params	A numeric vector of parameters.
Z	A numeric vector of covariates.
x	A numeric value representing the time point.

Value

A numeric value representing the PDF.

Examples

```
## Not run:
library(cmp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 2))
pdf_value <- f_pdf_rcpp2(params, Z[1, ], x[3])
print(pdf_value)

## End(Not run)
```

f_pdf_rcpp3

*Compute the PDF of the Parametric Proportional Hazards Model (PHM)***Description**

This function computes the probability density function (PDF) of the parametric model (PHM Approach).

Arguments

Params	A numeric vector of parameters.
Z	A numeric vector of covariates.
x	A numeric value representing the time point.

Value

A numeric value representing the PDF.

Examples

```
## Not run:
library(cmpp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 2))
pdf_value <- f_pdf_rcpp2(params, Z[1, ], x[3])
print(pdf_value)

## End(Not run)
```

 GetData

Retrieve Initialized Data from the Cmpp Model

Description

This function retrieves the data initialized in the Cmpp model, including the feature matrix, failure times, and competing risks indicators (delta1 and delta2).

Details

This function requires the Cmpp model to be initialized using the Initialize function. It retrieves the data stored in the Cmpp object, which includes the feature matrix, failure times, and the binary indicators for competing risks. If the Cmpp object is not initialized, the function will throw an error.

Value

A list containing:

features	A numeric matrix of predictor variables. Each row corresponds to an observation.
timee	A numeric vector of failure times corresponding to observations.
delta1	A binary vector indicating the occurrence of the first competing event (1 for observed).
delta2	A binary vector indicating the occurrence of the second competing event (1 for observed).

Examples

```
## Not run:
# Assuming the Cmpp model has been initialized
data <- GetData()
print(data$features) # Feature matrix
print(data$timee)   # Failure times
print(data$delta1)  # Indicator for the first competing event
```

```
print(data$delta2)    # Indicator for the second competing event

## End(Not run)
```

GetDim

Get Dimensions of the Cmpp Object

Description

This function returns the number of samples and features stored in the Cmpp object. It is primarily used to retrieve the dimensions of the data within the class.

Usage

```
GetDim()
```

Details

The GetDim function allows users to access the internal dimensions of the Cmpp class instance, such as the number of samples (Nsamp) and the number of features (Nfeature). This is useful when working with large datasets, especially for checking the size of the data without needing to manually access the underlying Eigen::MatrixXd or Eigen::VectorXd objects directly.

Value

A list containing:

Nsamp	Number of samples (rows in the feature matrix).
Nfeature	Number of features (columns in the feature matrix).

Examples

```
## Not run:
# Initialize Cmpp object
Initialize(features, x, delta1, delta2, h)
# Get dimensions
dims <- GetDim()
dims$Nsamp    # Number of samples
dims$Nfeature # Number of features

## End(Not run)
```

Initialize

Initialize Data for the Cmpp Model

Description

This function initializes the data used in the Cmpp model by storing the feature matrix, failure times, and the competing risks indicators in the model environment. These are required for subsequent computations.

Usage

```
Initialize(features, x, delta1, delta2, h)
```

Arguments

features	A numeric matrix of predictor variables. Each row corresponds to an observation.
x	A numeric vector of failure times corresponding to observations.
delta1	A binary vector indicating the occurrence of the first competing event (1 for observed).
delta2	A binary vector indicating the occurrence of the second event (1 for observed).
h	A numeric value specifying the step size for numerical gradient computations.

Details

This function does not return any value but sets up internal data structures required for model computation. Ensure that features, x, delta1, and delta2 have matching lengths or dimensions.

Value

This function returns NULL. The initialized data is stored in the package environment.

Examples

```
## Not run:
features <- matrix(rnorm(100), ncol = 5)
x <- rnorm(20)
delta1 <- sample(0:1, 20, replace = TRUE)
delta2 <- sample(0:1, 20, replace = TRUE)
Initialize(features, x, delta1, delta2, h = 1e-5)

## End(Not run)
```

LogLike1

Compute the Log-Likelihood for the Model

Description

Computes the negative log-likelihood of the Cmpp model given parameters and the initialized data. The log-likelihood considers Gompertz distributions for competing risks.

Usage

```
LogLike1(param)
```

Arguments

param A numeric vector of model parameters: alpha1, beta1, alpha2, beta2, where the first two are for the first event and the next two are for the second event.

Details

This function requires the data to be initialized using `Initialize` before being called. The log-likelihood is based on survival probabilities derived from the Gompertz distributions.

Value

A single numeric value representing the negative log-likelihood.

Examples

```
## Not run:
param <- c(0.01, 0.01, 0.01, 0.01)
LogLike1(param)

## End(Not run)
```

log_f_rcpp

Compute the Log-Likelihood Function Generalized Chance Model (GCM)

Description

This function computes the log-likelihood function for the parametric model (GCM Approach).

Arguments

Params A numeric vector of parameters.

Value

A numeric value representing the log-likelihood.

Examples

```
## Not run:
library(cmp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 3))
log_likelihood <- log_f_rcpp(params)
print(log_likelihood)

## End(Not run)
```

log_f_rcpp2	<i>Compute the Log-Likelihood Function Proportional Odds Model (POM)</i>
-------------	--

Description

This function computes the log-likelihood function for the parametric model (POM Approach).

Arguments

Params A numeric vector of parameters.

Value

A numeric value representing the log-likelihood.

Examples

```
## Not run:
library(cmp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 2))
log_likelihood <- log_f_rcpp2(params)
print(log_likelihood)

## End(Not run)
```

log_f_rcpp3	<i>Compute the Log-Likelihood Function Proportional Hazards Model (PHM)</i>
-------------	---

Description

This function computes the log-likelihood function for the parametric model (PHM Approach).

Arguments

Params A numeric vector of parameters.

Value

A numeric value representing the log-likelihood.

Examples

```
## Not run:
library(cmp)
features <- matrix(rnorm(300, 1, 2), nrow = 100, ncol = 3)
delta1 <- sample(c(0, 1), 100)
delta2 <- 1 - delta1
x <- rexp(100, rate = 1/10)
Initialize(features, x, delta1, delta2, h = 1e-5)
params <- rep(0.001, 2 * (ncol(features) + 2))
log_likelihood <- log_f_rcpp2(params)
print(log_likelihood)

## End(Not run)
```

makeMat	<i>Create a matrix of given size filled with a constant value</i>
---------	---

Description

This function creates an $n \times m$ matrix of type `Eigen::MatrixXd`, where each element is set to the specified constant value. This is useful for generating matrices with uniform values for testing, initialization, or other purposes in computational tasks where a matrix filled with a constant is needed.

Usage

```
makeMat(n, m, value)
```

Arguments

n An integer representing the number of rows in the matrix.

m An integer representing the number of columns in the matrix.

value A numeric value that will be used to fill the matrix.

Details

The `makeMat` function generates a matrix with the given dimensions $n \times m$ where all elements are initialized to the same constant value. It is useful in scenarios where a specific value needs to be assigned to all elements of the matrix, for example in machine learning algorithms, matrix manipulations, or tests.

Value

A numeric matrix of dimensions $n \times m$ filled with the specified value.

Examples

```
## Not run:
# Create a 3x3 matrix filled with 5
mat <- makeMat(3, 3, 5)
print(mat)

## End(Not run)
```

make_Dummy

Create Dummy Variables

Description

This function creates dummy variables for specified features in a dataset.

Usage

```
make_Dummy(Data = dat, features = c("sex", "cause_burn"), reff = "first")
```

Arguments

<code>Data</code>	A data frame containing the data.
<code>features</code>	A character vector of feature names for which dummy variables are to be created.
<code>reff</code>	A character string indicating the reference level. It can be either "first" or "last".

Value

A list containing two elements:

<code>New_Data</code>	A data frame with the original data and the newly created dummy variables.
<code>Original_Data</code>	The original data frame.

Examples

```
dat <- data.frame(sex = c('M', 'F', 'M'), cause_burn = c('A', 'B', 'A'))
result <- make_Dummy(Data = dat, features = c('sex', 'cause_burn'), reff = "first")
print(result$New_Data)
```

pdf_gomp*Compute the PDF of the Gompertz Distribution*

Description

Calculates the probability density function (PDF) of the Gompertz distribution for given input values and parameters.

Usage

```
pdf_gomp(x, alpha, beta)
```

Arguments

x	A numeric vector of non-negative input values (e.g., failure times).
alpha	A positive numeric value representing the shape parameter.
beta	A positive numeric value representing the scale parameter.

Details

The PDF provides the relative likelihood of a failure or event occurring at specific time points. Ensure that alpha and beta are positive for meaningful results.

Value

A numeric vector of the PDF values for each input in x.

Examples

```
## Not run:  
x <- c(1, 2, 3)  
alpha <- 0.5  
beta <- 0.1  
pdf_gomp(x, alpha, beta)  
  
## End(Not run)
```

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