

Package ‘RESTK’

January 20, 2025

Title An Implementation of the RESTK Algorithm

Version 1.0.0

Description Implementation of the RESTK algorithm based on Markov's Inequality from Vilardell, Sergi, Serra, Isabel, Mezzetti, Enrico, Abella, Jaume, Cazorla, Francisco J. and Del Castillo, J. (2022). "Using Markov's Inequality with Power-Of-k Function for Probabilistic WCET Estimation". In 34th Euromicro Conference on Real-Time Systems (ECRTS 2022). Leibniz International Proceedings in Informatics (LIPIcs) 231 20:1-20:24. <[doi:10.4230/LIPIcs.ECRTS.2022.20](https://doi.org/10.4230/LIPIcs.ECRTS.2022.20)>. This work has been supported by the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (grant agreement No. 772773).

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Encoding UTF-8

RoxygenNote 7.2.3

Imports purrr

Suggests knitr, rmarkdown

NeedsCompilation no

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Repository CRAN

Date/Publication 2023-08-22 18:20:02 UTC

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compute_maxk	<i>Compute the maximum k for a given sample</i>
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Description

compute_maxk returns the estimated quantiles for the chosen probabilities from the input sample. This method uses the sample quantile method number 8 from the default quantile function.

Usage

```
compute_maxk(samp = NULL, probs = NULL, quants = NULL, k_range = c(1, 120))
```

Arguments

samp	Sample of data to model
probs	Probabilities of interest to generate the max_k line
quants	Estimated quantiles of interest to generate the max_k line
k_range	Range of k values for the optimization function

Value

Returns estimated maxk for the sample and quantiles given.

Examples

```
samp <- rnorm(1e3, mean = 100, sd = 10)
probs <- c(1-1e-1, 1-0.5e-1, 1-1e-2)
quants <- c(100, 125, 150)
estimated_max_k <- compute_maxk(samp = samp, probs = probs, quants = quants, k_range = c(1,100))
```

estimate_quantiles_maxk

Estimate Quantiles with Maxk

Description

estimate_quantiles_maxk use the maxk line obtained to estimate quantiles with MIK

Usage

```
estimate_quantiles_maxk(samp = NULL, maxk_line = NULL, probs_interest = NULL)
```

Arguments

samp sample
maxk_line maxk line obtained for the probabilities of interest
probs_interest Probabilities of interest to estimate

Value

Returns the estimation of the quantiles using the maxk line

Examples

```
linear_adjust(min_maxk = c(10, 15, 20),  
              probs = c(1-1e-1, 1-1e-2, 1-1e-3),  
              probs_interest = c(1-1e-6, 1-1e-7, 1-1e-8))
```

get_min_maxk	<i>Get the minimum maxk</i>
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Description

get_min_maxk get the minimum maxk from a set of maxks and tightness

Usage

```
get_min_maxk(samp_tightness = NULL, k_seq = NULL)
```

Arguments

samp_tightness tightness from a given sample and maxk
k_seq sequence of maxk to evaluate

Value

Returns the minimum maxk

Examples

```
get_min_maxk(samp_tightness = c(1.5, 1.2, 0.98),  
              k_seq = c(20, 30 , 40))
```

linear_adjust	<i>Linear adjust</i>
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Description

linear_adjust function used to project the max_k line into the probabilities of interest

Usage

```
linear_adjust(min_maxk = NULL, probs = NULL, probs_interest)
```

Arguments

min_maxk	minimum maxk found for each probability of interest
probs	Probabilities where maxk was evaluated
probs_interest	Probabilities of interest to estimate

Value

Returns the maxk line for the probabilities of interest

Examples

```
linear_adjust(min_maxk = c(10, 15, 20),
              probs = c(1-1e-1, 1-1e-2, 1-1e-3),
              probs_interest = c(1-1e-6, 1-1e-7, 1-1e-8))
```

RESTK	<i>RESTK</i>
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Description

RESTK function used to project the maxk line into the probabilities of interest

Usage

```
RESTK(
  training_data = NULL,
  validation_data = NULL,
  probs = NULL,
  probs_interest = NULL,
  bootstrap_size = NULL,
  bootstrap_training_sims = NULL,
  bootstrap_validation_sims = NULL
)
```

Arguments

training_data training data
validation_data validation data
probs Probabilities where maxk was evaluated
probs_interest Probabilities of interest to estimate
bootstrap_size size of bootstrap simulations on the training data
bootstrap_training_sims number of bootstrap simulations on the training data
bootstrap_validation_sims number of bootstrap simulations on the validation data

Value

Returns the maxk line for the probabilities of interest

Examples

```
training_data <- rnorm(1e3, mean = 100, sd = 10)
validation_data <- rnorm(1e3, mean = 100, sd = 10)
bootstrap_size <- 1000
bootstrap_training_sims <- 10
bootstrap_validation_sims <- 10
probs <- c(1-1e-1, 1-0.5e-1, 1-1e-2)
probs_interest <- c(1-1e-6, 1-1e-7)
maxk_line <- c(100, 125, 150)

estimated_quants <- RESTK(training_data = training_data,
                          validation_data = validation_data,
                          probs = probs,
                          probs_interest = probs_interest,
                          bootstrap_size = bootstrap_size,
                          bootstrap_training_sims = bootstrap_training_sims,
                          bootstrap_validation_sims = bootstrap_validation_sims)
```

RESTK_training

RESTK Training

Description

RESTK_training function used to project the maxk line into the probabilities of interest

Usage

```
RESTK_training(  
  training_data = NULL,  
  probs = NULL,  
  probs_interest = NULL,  
  bootstrap_size = NULL,  
  bootstrap_training_sims = NULL  
)
```

Arguments

training_data training data

probs Probabilities where maxk was evaluated

probs_interest Probabilities of interest to estimate

bootstrap_size size of bootstrap simulations on the training data

bootstrap_training_sims
 number of bootstrap simulations on the training data

Value

Returns the estimated maxk line from the probabilities of interest

Examples

```
training_data <- rnorm(1e3, mean = 100, sd = 10)  
probs <- c(1-1e-1, 1-0.5e-1, 1-1e-2)  
probs_interest <- c(1-1e-6, 1-1e-7)  
bootstrap_size <- 1000  
bootstrap_training_sims <- 100  
  
maxk_line <- RESTK_training(training_data = training_data,  
                            probs = probs,  
                            probs_interest = probs_interest,  
                            bootstrap_size = bootstrap_size,  
                            bootstrap_training_sims = bootstrap_training_sims)
```

RESTK_validation *RESTK Validation*

Description

RESTK_validation main function for the validation of the RESTK methodology by using the maxk line

Usage

```
RESTK_validation(  
  validation_data = NULL,  
  maxk_line = NULL,  
  probs_interest = NULL,  
  bootstrap_size = NULL,  
  bootstrap_validation_sims = NULL  
)
```

Arguments

validation_data	validation data
maxk_line	maxk line obtained from RESTK_training
probs_interest	Probabilities of interest to estimate
bootstrap_size	size of bootstrap simulations on the validation data
bootstrap_validation_sims	number of bootstrap simulations on the validation data

Value

Returns the estimated quantiles from the probabilities of interest

Examples

```
validation_data <- rnorm(1e3, mean = 100, sd = 10)  
probs_interest <- c(1-1e-6, 1-1e-7)  
bootstrap_size <- 1000  
bootstrap_validation_sims <- 100  
maxk_line <- c(100, 125, 150)  
estimated_quants <- RESTK_validation(validation_data = validation_data,  
                                     maxk_line = maxk_line,  
                                     probs_interest = probs_interest,  
                                     bootstrap_size = bootstrap_size,  
                                     bootstrap_validation_sims = bootstrap_validation_sims)
```

sample_quantile_estimation

Estimate Quantiles within the Sample

Description

sample_quantile_estimation returns the estimated quantiles for the chosen probabilities from the input sample. This method uses the sample quantile method number 8 from the default quantile function.

Usage

```
sample_quantile_estimation(samp = NULL, probs = NULL, bootstrap_sims = NULL)
```

Arguments

samp Sample of data to model
 probs Probabilities of interest to generate the max_k line
 bootstrap_sims Number of bootstrap simulations to estimate the quantiles

Value

Returns estimated quantiles for the chosen probabilities.

Examples

```
samp <- rnorm(1e3, mean = 100, sd = 10)
probs <- c(1-1e-1, 1-0.5e-1, 1-1e-2)
bootstrap_training_sims <- 100
estimated_quantiles <- sample_quantile_estimation(samp = samp,
                                                  probs = probs,
                                                  bootstrap_sims = bootstrap_training_sims)
```

tightness	<i>Tightness function</i>
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Description

tightness function used to minimized the tightness as a function of the value of k

Usage

```
tightness(samp = NULL, prob = NULL, quant = NULL, k = NULL)
```

Arguments

samp Sample of data to model
 prob Probability of interest
 quant Quantile of interest
 k value of k to check tightness

Value

Returns the squared difference between the tightness and 1

Examples

```
samp <- rnorm(1e3, mean = 100, sd = 10)
prob <- c(1-1e-2)
k <- 1:100
quant <- qnorm(p = prob, mean = 100, sd = 10)
tightness(samp = samp, prob = prob, quant = quant, k = k)
```

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