Package ‘irace’

April 27, 2019

Type  Package
Title  Iterated Racing for Automatic Algorithm Configuration
Description  Iterated race is an extension of the Iterated F-race method for
the automatic configuration of optimization algorithms, that is,
(offline) tuning their parameters by finding the most appropriate
settings given a set of instances of an optimization problem.
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Author  Manuel López-Ibáñez [aut, cre]
        (https://orcid.org/0000-0001-9974-1295),
        Jérémie Dubois-Lacoste [aut],
        Leslie Pérez Cáceres [aut],
        Thomas Stützle [aut],
        Mauro Birattari [aut],
        Eric Yuan [ctb],
        Prasanna Balaprakash [ctb]
Maintainer  Manuel López-Ibáñez <manuel.lopez-ibanez@manchester.ac.uk>
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Description

Iterated race is an extension of the Iterated F-race method for the automatic configuration of optimization algorithms, that is, (offline) tuning their parameters by finding the most appropriate settings given a set of instances of an optimization problem.
Details

License: GPL (>= 2)

Author(s)

Maintainers: Manuel López-Ibáñez and Leslie Pérez Cáceres <irace-package@googlegroups.com>

References


See Also

irace.main to start irace with a given scenario.

Examples

```r
# This example illustrates how to tune the parameters of the simulated annealing algorithm (SANN) provided by the optim() function in the R base package. The goal in this example is to optimize instances of the following family:
# f(x) = lambda * f_rastrigin(x) + (1 - lambda) * f_rosenbrock(x)
# where lambda follows a normal distribution whose mean is 0.9 and standard deviation is 0.02. f_rastrigin and f_rosenbrock are the well-known Rastrigin and Rosenbrock benchmark functions (taken from the cmaes package). In this scenario, different instances are given by different values of lambda.

# First we provide an implementation of the functions to be optimized:

f_rosenbrock <- function (x) {
  d <- length(x)
  z <- x + 1
  hz <- z[1:(d - 1)]
  tz <- z[2:d]
  s <- sum(100 * (hz^2 - tz)^2 + (hz - 1)^2)
  return(s)
}
f_rastrigin <- function (x) {
  sum(x * x - 10 * cos(2 * pi * x) + 10)
}

# We generate 200 instances (in this case, weights):
```
weights <- rnorm(200, mean = 0.9, sd = 0.02)

## On this set of instances, we are interested in optimizing two
## parameters of the SANN algorithm: tmax and temp. We setup the
## parameter space as follows:
parameters.table <-#
  tmax "" i (1, 5000)
  temp "" r (0, 100)

## We use the irace function readParameters to read this table:
parameters <- readParameters(text = parameters.table)

## Next, we define the function that will evaluate each candidate
## configuration on a single instance. For simplicity, we restrict to
## three-dimensional functions and we set the maximum number of
## iterations of SANN to 5000.
target.runner <- function(experiment, scenario)
{
  instance <- experiment$instance
  configuration <- experiment$configuration

  D <- 3
  par <- runif(D, min=-1, max=1)
  fn <- function(x) {
    weight <- instance
    return(weight * f_ras trigin(x) + (1 - weight) * f_rosenbrock(x))
  }
  res <- stats::optim(par, fn, method="SANN",
    control=list(maxit=5000,
      tmax = as.numeric(configuration[["tmax"]]),
      temp = as.numeric(configuration[["temp"]]))
)

## New output interface in irace 2.0. This list may also contain:
## - 'time' if irace is called with 'maxTime'
## - 'error' is a string used to report an error
## - 'outputRaw' is a string used to report the raw output of calls to
##   an external program or function.
## - 'call' is a string used to report how target.runner called the
##   external program or function.
  return(list(cost = res$value))
}

## We define a configuration scenario by setting targetRunner to the
## function define above, instances to the first 100 random weights, and
## a maximum budget of 1000 calls to targetRunner.
scenario <- list(targetRunner = target.runner,
  instances = weights[1:100],
  maxExperiments = 1000,
  # Do not create a logFile
  logFile = "")

## We check that the scenario is valid. This will also try to execute
## ablation

Performs ablation between two configurations.

### Description

Ablation is a method for analyzing the differences between two configurations.

### Usage

```r
ablation(iraceLogfile = NULL, iraceResults = NULL, src = NULL,
         target = NULL, ab.params = NULL, n.instances = NULL,
         type = "full", seed = 1234567,
```
ablationLogfile = "log-ablation.Rdata", pdf.file = NULL,
               pdf.width = 20, mar = c(12, 5, 4, 1), debugLevel = NULL)

Arguments

iraceLogFile Log file created by irace, this file must contain the iraceResults object.
iraceResults Object created by irace and saved in scenarioDlogfile.
src, target Source and target configuration IDs. If NULL, then the first configuration ever
evaluated is used as source and the best configuration found is used as target.
ab.params Parameter names to be used for the ablation. They must be in parameters$names.
n.instances Number of instances to be used for the "full" ablation, if not provided firstTest
instances are used.
type Type of ablation to perform, "full" will execute all instances in the configurations
to determine the best performing, "racing" will apply racing to find the best
configurations.
seed Numerical value to use as seed for the random number generation.
ablationLogFile Log file to save the ablation log.
pdf.file Prefix that will be used to save the plot file of the ablation results.
pdf.width Width provided to create the pdf file.
mar Vector with the margins for the ablation plot.
debugLevel Integer value. Larger values produce more verbose output. By default, the de-
bugLevel given by the iraceLogFile/iraceResults.

Value

A list containing the following elements:

- configurations Configurations tested in the ablation.
- instances A matrix with the instances used in the experiments. First column has the instances IDs
  from iraceResults$scenario$instances, second column the seed assigned to the instance.
- experiments A matrix with the results of the experiments (columns are configurations, rows are
  instances).
- scenario Scenario object with the settings used for the experiments.
- trajectory IDs of the best configurations at each step of the ablation.
- best Best configuration found in the experiments.

Author(s)

Leslie Pérez Cáceres and Manuel López-Ibáñez

References

C. Fawcett and H. H. Hoos. Analysing differences between algorithm configurations through abla-
buildCommandLine

Examples

irace.logfile <- file.path(system.file(package="irace"), "exdata", "sann.rda")
load(irace.logfile)
# Execute ablation between the first and the best configuration found by irace.
ablation(iraceResults = iraceResults, ablationLogFile = "null")
# Execute ablation between two selected configurations, and selecting only a
# subset of parameters, directly reading the setup from the irace log file.
ablation(iraceLogFile = irace.logfile, src = 1, target = 10,
         ab.params = c("temp"), ablationLogFile = NULL)

buildCommandLine Generate a command-line representation of a configuration

Description

buildCommandLine receives two vectors, one containing the values of the parameters, the other
containing the switches of the parameters. It builds a string with the switches and the values that
can be used as a command line to call the program to be tuned, thus generating one candidate
configuration.

Usage

buildCommandLine(values, switches)

Arguments

values A vector containing the value of each parameter for the candidate configuration.
switches A vector containing the switches of each parameter (in an order that corresponds
to the values vector).

Value

A string concatenating each element of switches and values for all parameters with a space be-
tween each pair of parameters (but none between the switches and the corresponding values).

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste
Examples

```r
switches <- c("--switch1", "--switch2")
values <- c("value_1", "value_2")
buildCommandLine(values, switches)
## Build a command-line from the results produced by a previous run of irace.
# First, load the data produced by irace.
irace.logfile <- file.path(system.file(package="irace"),
  "exdata", "irace-acotsp.Rdata")
load(irace.logfile)
attach(iraceresults)
apply(allConfigurations[1:10, unlist(parameters$names)], 1, buildCommandLine,
  unlist(parameters$switches))
```

checkIraceScenario Test that the given irace scenario can be run.

Description

checkIraceScenario tests that the given irace scenario can be run by checking the scenario settings provided and trying to run the target-algorithm.

Usage

```r
checkIraceScenario(scenario, parameters = NULL)
```

Arguments

- **scenario**: Data structure containing `irace` settings. The data structure has to be the one returned by the function `defaultScenario` and `readScenario`.
- **parameters**: Data structure containing the parameter definition. The data structure has to be the one returned by the function `readParameters`. See documentation of this function for details.

Details

Provide the `parameters` argument only if the parameter list should not be obtained from the parameter file given by the scenario. If the parameter list is provided it will not be checked. This function will try to execute the target-algorithm.

Value

returns TRUE if successful and gives an error and returns FALSE otherwise.

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste
checkScenario

Description

checkScenario takes a (possibly incomplete) scenario setup of irace, checks for errors and transforms it into a valid scenario.

Usage

checkScenario(scenario = defaultScenario())

Arguments

scenario  A list where tagged elements correspond to scenario settings of irace.

Details

This function checks that the directories and the file names provided and required by the irace exist. It also checks that the settings are of the proper type, e.g. that settings expected to be integers are really integers. Finally, it also checks that there is no inconsistency between settings. If an error is found that prevents irace from running properly, it will stop with an error.

Value

The scenario received as a parameter, possibly corrected. Unset scenario settings are set to their default values.

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

See Also

readScenario for reading a configuration scenario from a file.
printScenario prints the given scenario.
defaultScenario returns the default scenario settings of irace.
checkScenario to check that the scenario is valid.
configurations.print

*Print configurations as a data frame*

**Description**

Print configurations as a data frame.

**Usage**

```r
configurations.print(configurations, metadata = FALSE)
```

**Arguments**

- `configurations`: a data frame containing the configurations (one per row).
- `metadata`: A Boolean specifying whether to print the metadata or not. The metadata are data for the configurations (additionally to the value of each parameter) used by `irace`.

**Value**

None.

**Author(s)**

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

**See Also**

`configurations.print.command` to print the configurations as command-line strings.

---

configurations.print.command

*Print configurations as command-line strings.*

**Description**

Prints configurations after converting them into a representation for the command-line.

**Usage**

```r
configurations.print.command(configurations, parameters)
```

**Arguments**

- `configurations`: a data frame containing the configurations (one per row).
- `parameters`: A data structure similar to that provided by the `readParameters` function.
Value
None.

Author(s)
Manuel López-Ibáñez and Jérémie Dubois-Lacoste

See Also
configurations.print to print the configurations as a data frame.

Description
Creates box plots of the quality of configurations.

Usage

configurationsBoxplot(experiments, title = NULL, 
  xlabel = "Configuration ID", ylabel = "Configuration cost", 
  filename = NULL)

Arguments

  experiments    Matrix of performance of configurations (columns) over a set of instances (rows).
  title          (NULL) Title for the plot.
  xlabel         Label for the x axis.
  ylabel         Label for the y axis.
  filename       (NULL) Filename prefix to create a pdf file with the plot.

Value
Box plot of the performance of the configurations.

Author(s)
Manuel López-Ibáñez and Leslie Pérez Cáceres
**Default scenario settings**

**Description**

Return scenario with default values.

**Usage**

```r
defaultScenario(scenario = list())
```

**Arguments**

- `scenario` A list where tagged elements correspond to scenario settings of `irace`.

**Value**

A list indexed by the `irace` parameter names, containing the default values for each parameter, except for those already present in the scenario passed as argument. The scenario list contains the following elements:

- **General options:**
  - `scenarioFile` Path of the file that describes the configuration scenario setup and other `irace` settings. (Default: `.\.scenario.txt")
  - `execDir` Directory where the programs will be run. (Default: "./")
  - `logfile` File to save tuning results as an R dataset, either absolute path or relative to `execDir`. (Default: ".\irace.Rdata")
  - `debugLevel` Debug level of the output of `irace`. Set this to 0 to silence all debug messages. Higher values provide more verbose debug messages. (Default: 0)
  - `seed` Seed of the random number generator (by default, generate a random seed). (Default: NA)
  - `repairConfiguration` User-defined R function that takes a configuration generated by `irace` and repairs it. (Default: "")
  - `postselection` Percentage of the configuration budget used to perform a postselection race of the best configurations of each iteration after the execution of `irace`. (Default: 0)
  - `aclib` Enable/disable AClib mode. This option enables compatibility with GenericWrapper4AC as `targetRunner` script. (Default: 0)

- **Elitist `irace`:**
  - `elitist` Enable/disable elitist `irace`. (Default: 1)
  - `elitistNewInstances` Number of instances added to the execution list before previous instances in elitist `irace`. (Default: 1)
  - `elitistLimit` In elitist `irace`, maximum number per race of elimination tests that do not eliminate a configuration. Use 0 for no limit. (Default: 2)

- **Internal `irace` options:**
  - `nbIterations` Number of iterations. (Default: 0)
nbExperimentsPerIteration  Number of runs of the target algorithm per iteration. (Default: 0)
sampleInstances  Randomly sample the training instances or use them in the order given. (Default: 1)
minNbSurvival  Minimum number of configurations needed to continue the execution of each race (iteration). (Default: 0)
nbConfigurations  Number of configurations to be sampled and evaluated at each iteration. (Default: 0)
mu  Parameter used to define the number of configurations sampled and evaluated at each iteration. (Default: 5)
softRestart  Enable/disable the soft restart strategy that avoids premature convergence of the probabilistic model. (Default: 1)
softRestartThreshold  Soft restart threshold value for numerical parameters. If NA, NULL or ",, it is computed as 10^-digits. (Default: ")

• Target algorithm parameters:
parameterFile  File that contains the description of the parameters of the target algorithm. (Default: "./parameters.txt")
forbiddenExps  Vector of R logical expressions that cannot evaluate to TRUE for any evaluated configuration. (Default: ")
forbiddenFile  File that contains a list of logical expressions that cannot be TRUE for any evaluated configuration. If empty or NULL, do not use forbidden expressions. (Default: ")
digits  Maximum number of decimal places that are significant for numerical (real) parameters. (Default: 4)

• Target algorithm execution:
targetRunner  Script called for each configuration that executes the target algorithm to be tuned. See templates. (Default: "./target-runner")
targetRunnerRetries  Number of times to retry a call to targetRunner if the call failed. (Default: 0)
targetRunnerData  Optional data passed to targetRunner. This is ignored by the default targetRunner function, but it may be used by custom targetRunner functions to pass persistent data around. (Default: ")
targetRunnerParallel  Optional R function to provide custom parallelization of targetRunner. (Default: ")
targetEvaluator  Optional script or R function that provides a numeric value for each configuration. See templates/target-evaluator.tmpl (Default: ")
deterministic  If the target algorithm is deterministic, configurations will be evaluated only once per instance. (Default: 0)
parallel  Number of calls to targetRunner to execute in parallel. Values 0 or 1 mean no parallelization. (Default: 0)
loadBalancing  Enable/disable load-balancing when executing experiments in parallel. Load-balancing makes better use of computing resources, but increases communication overhead. If this overhead is large, disabling load-balancing may be faster. (Default: 1)
mpi  Enable/disable MPI. Use Rmpi to execute targetRunner in parallel (parameter parallel is the number of slaves). (Default: 0)
batchmode Specify how irace waits for jobs to finish when targetRunner submits jobs to a
batch cluster: sge, pbs, torque or slurm. targetRunner must submit jobs to the cluster
using, for example, qsub. (Default: 0)

• Initial configurations:
  - configurationsFile File that contains a set of initial configurations. If empty or NULL, all
    initial configurations are randomly generated. (Default: ")

• Training instances:
  - instances Character vector of the instances to be used in the targetRunner. (Default: ")
  - trainInstancesDir Directory where training instances are located; either absolute path or
    relative to current directory. If no trainInstancesFiles is provided, all the files in
    trainInstancesDir will be listed as instances. (Default: ". /Instances")
  - trainInstancesFile File that contains a list of training instances and optionally additional
    parameters for them. If trainInstancesDir is provided, irace will search for the files
    in this folder. (Default: ")

• Tuning budget:
  - maxExperiments Maximum number of runs (invocations of targetRunner) that will be per-
    formed. It determines the maximum budget of experiments for the tuning. (Default: 0)
  - maxTime Maximum total execution time in seconds for the executions of targetRunner.
    targetRunner must return two values: cost and time. (Default: 0)
  - budgetEstimation Fraction (smaller than 1) of the budget used to estimate the mean com-
    putation time of a configuration. Only used when maxTime > 0 (Default: 0.02)

• Statistical test:
  - testType Statistical test used for elimination. Default test is always F-test unless capping
    is enabled, in which case the default test is t-test. Valid values are: F-test (Friedman
    test), t-test (pairwise t-tests with no correction), t-test-bonferroni (t-test with Bonferroni’s
    correction for multiple comparisons), t-test-holm (t-test with Holm’s correction for mul-
    tiple comparisons). (Default: "F-test")
  - firstTest Number of instances evaluated before the first elimination test. It must be a mul-
    tiple of eachTest. (Default: 5)
  - eachTest Number of instances evaluated between elimination tests. (Default: 1)
  - confidence Confidence level for the elimination test. (Default: 0.95)

• Adaptive capping:
  - capping Enable the use of adaptive capping, a technique designed for minimizing the com-
    putation time of configurations. This is only available when elitist is active. (Default: 0)
  - cappingType Measure used to obtain the execution bound from the performance of the elite
    configurations.
    - median: Median performance of the elite configurations.
    - mean: Mean performance of the elite configurations.
    - best: Best performance of the elite configurations.
    - worst: Worst performance of the elite configurations.
    (Default: "median")
  - boundType Method to calculate the mean performance of elite configurations.
- candidate: Mean execution times across the executed instances and the current one.
- instance: Execution time of the current instance.
  (Default: "candidate")

boundMax  Maximum execution bound for targetRunner. It must be specified when capping is enabled. (Default: 0)

boundDigits  Precision used for calculating the execution time. It must be specified when capping is enabled. (Default: 0)

boundPar  Penalization constant for timed out executions (executions that reach boundMax execution time). (Default: 1)

boundAsTimeout  Replace the configuration cost of bounded executions with boundMax. (Default: 1)

- Recovery:

  recoveryFile  Previously saved log file to recover the execution of irace, either absolute path or relative to the current directory. If empty or NULL, recovery is not performed. (Default: "")

- Testing:

  testInstancesDir  Directory where testing instances are located, either absolute or relative to current directory. (Default: ")

  testInstancesFile  File containing a list of test instances and optionally additional parameters for them. (Default: "")

  testInstances  Character vector of the instances to be used in the targetRunner when executing the testing. (Default: ")

  testNbElites  Number of elite configurations returned by irace that will be tested if test instances are provided. (Default: 1)

  testIterationElites  Enable/disable testing the elite configurations found at each iteration. (Default: 0)

**Author(s)**

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

**See Also**

* readScenario  for reading a configuration scenario from a file.
* printScenario  prints the given scenario.
* defaultScenario  returns the default scenario settings of irace.
* checkScenario  to check that the scenario is valid.
getDescriptionByIteration

Returns the configurations by the iteration in which they were executed.

Description

Returns the configurations by the iteration in which they were executed.

Usage

generateDescriptionByIteration(iraceResults = NULL, logFile = NULL, iterations, drop.metadata = FALSE)

Arguments

iraceResults Object created by irace and saved in scenario$logfile.
logFile Log file created by irace, this file must contain the iraceResults object.
iterations The id or a vector of ids of the candidates configurations to obtain.
drop.metadata Remove metadata, such the configuration ID and the ID of the parent, from the returned configurations. See removeConfigurationsMetadata.

Value

A data frame containing the elite configurations required.

Author(s)

Manuel López-Ibáñez and Leslie Pérez Cáceres
getFinalElites

Arguments

- **iraceResults**: (NULL) Object created by **irace** and saved in `scenario$logfile`.
- **logfile**: (NULL) Log file created by **irace**, this file must contain the `iraceResults` object.
- **iterations**: The iteration number or a vector of iteration numbers from where the configurations should be obtained.
- **drop.metadata**: (FALSE) Remove metadata, such the configuration ID and the ID of the parent, from the returned configurations. See `removeConfigurationsMetaData`.

Value

A data frame containing the elite configurations required.

Author(s)

Manuel López-Ibáñez and Leslie Pérez Cáceres

Description

Return the elite configurations of the final iteration.

Usage

```r
getFinalElites(iraceResults = NULL, logfile = NULL, n = 0, drop.metadata = FALSE)
```

Arguments

- **iraceResults**: Object created by **irace** and saved in `scenario$logfile`.
- **logfile**: Log file created by **irace**, this file must contain the `iraceResults` object.
- **n**: Number of elite configurations to return, if n is larger than the number of configurations, then only the existing ones are returned.
- **drop.metadata**: Remove metadata, such the configuration ID and the ID of the parent, from the returned configurations. See `removeConfigurationsMetaData`.

Value

A data frame containing the elite configurations required.

Author(s)

Manuel López-Ibáñez and Leslie Pérez Cáceres
Description

`irace` implements iterated Race. It receives some parameters to be tuned and returns the best configurations found, namely, the elite configurations obtained from the last iterations (and sorted by rank).

Usage

`irace(scenario, parameters)`

Arguments

- `scenario` Data structure containing `irace` settings. The data structure has to be the one returned by the function `defaultScenario` and `readScenario`.
- `parameters` Data structure containing the parameter definition. The data structure has to be the one returned by the function `readParameters`.

Details

The function `irace` executes the tuning procedure using the information provided in `scenario` and `parameters`. Initially it checks the correctness of `scenario` and recovers a previous execution if `scenario$recoveryFile` is set. A R data file log of the execution is created in `scenario$logFile`.

Value

A data frame with the set of best algorithm configurations found by `irace`. The data frame has the following columns:

- `.ID.` Internal id of the candidate configuration.
- `Parameter names` One column per parameter name in `parameters`.
- `.PARENT` Internal id of the parent candidate configuration.

Additionally, this function saves an R data file containing an object called `iraceResults`. The path of the file is indicated in `scenario$logFile`. The `iraceResults` object is a list with the following structure:

- `scenario` The scenario R object containing the `irace` options used for the execution. See `defaultScenario` help for more information.
- `parameters` The parameters R object containing the description of the target algorithm parameters. See `readParameters`.
allConfigurations The target algorithm configurations generated by \texttt{irace}. This object is a data frame, each row is a candidate configuration, the first column (\.ID\.) indicates the internal identifier of the configuration, the following columns correspond to the parameter values, each column named as the parameter name specified in the parameter object. The final column (\.PARENT\.) is the identifier of the configuration from which model the actual configuration was sampled.

allElites A list that contains one element per iteration, each element contains the internal identifier of the elite candidate configurations of the corresponding iteration ( identifiers correspond to \texttt{allConfigurations$\.ID\.}).

iterationElites A vector containing the best candidate configuration internal identifier of each iteration. The best configuration found corresponds to the last one of this vector.

experiments A matrix with configurations as columns and instances as rows. Column names correspond to the internal identifier of the configuration ( \texttt{allConfigurations$\.ID\.}).

experimentLog A matrix with columns iteration, instance, configuration, time. This matrix contains the log of all the experiments that \texttt{irace} performs during its execution. The instance column refers to the index of the \texttt{scenario$instancesList} data frame. Time is saved ONLY when reported by the targetRunner.

softRestart A logical vector that indicates if a soft restart was performed on each iteration. If \texttt{FALSE}, then no soft restart was performed.

state A list that contains the state of \texttt{irace}, the recovery is done using the information contained in this object.

testing A list that contains the testing results. The elements of this list are: experiments a matrix with the testing experiments of the selected configurations in the same format as the explained above and seeds a vector with the seeds used to execute each experiment.

\textbf{Author(s)}

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

\textbf{See Also}

\texttt{irace.main} a higher-level command-line interface to \texttt{irace}.
\texttt{readScenario} for reading a configuration scenario from a file.
\texttt{readParameters} read the target algorithm parameters from a file.
\texttt{defaultScenario} returns the default scenario settings of \texttt{irace}.
\texttt{checkScenario} to check that the scenario is valid.

\textbf{Examples}

## Not run:

```r
parameters <- readParameters("parameters.txt")
scenario <- readScenario(filename = "scenario.txt",
                          scenario = defaultScenario())
irace(scenario = scenario, parameters = parameters)
```

## End(Not run)
irace.cmdline

Description

irace.cmdline starts **irace** using the parameters of the command line used to invoke R.

Usage

```r
irace.cmdline(args = commandArgs(trailingOnly = TRUE))
```

Arguments

- `args` commandArgs(trailingOnly = TRUE) The arguments provided on the R command line as a character vector, e.g., `c("--scenario", "scenario.txt", "-p", "parameters.txt")`. Using the default value (not providing the parameter) is the easiest way to call `irace.cmdline`.

Details

The function reads the parameters given on the command line used to invoke R, finds the name of the scenario file, initializes the scenario from the file (with the function `readScenario`) and possibly from parameters passed on the command line. It finally starts **irace** by calling `irace.main`.

Value

None.

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

See Also

- [irace.main](#) to start **irace** with a given scenario.

irace.license

Description

A character string containing the license information of **irace**.

Usage

```r
irace.license
```
**irace.main**

**Format**

An object of class character of length 1.

**Description**

irace.main is a higher-level interface to invoke *irace*.

**Usage**

irace.main(scenario = defaultScenario(), output.width = 9999)

**Arguments**

- **scenario** `defaultScenario()` The scenario setup of *irace*.
- **output.width** 9999 The width that must be used for the screen output.

**Details**

The function `irace.main` checks the correctness of the scenario, prints it, reads the parameter space from `scenario$parameterFile`, invokes `irace` and prints its results in various formatted ways. If you want a lower-level interface, please see function `irace`.

**Author(s)**

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

**See Also**

*irace.cmdline* a higher-level command-line interface to *irace.main*. *readScenario* to read the scenario setup from a file. *defaultScenario* to provide a default scenario for *irace*. 
Description

irace.usage This function prints all command-line options of irace, with the corresponding switches and a short description.

Usage

irace.usage()

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

Description

A character string containing the version of irace.

Usage

irace.version

Format

An object of class character of length 1.

Description

parallelCoordinatesPlot plots a set of parameter configurations in parallel coordinates.

Usage

parallelCoordinatesPlot(configurations, parameters, param_names = parameters$names, hierarchy = TRUE, filename = NULL, pdf.width = 14, mar = c(8, 1, 4, 1))
**parameterFrequency**

**Arguments**

- **configurations**  
  Data frame containing target algorithms configurations in the format used by `irace`.
- **parameters**  
  List of target algorithm parameters in the `irace` format.
- **param_names**  
  Parameters names that should be included. Default: parameters$names.
- **hierarchy**  
  If TRUE conditional parameters will be displayed in a different plot. Default TRUE.
- **filename**  
  Filename prefix to generate the plots. If NULL the plot displayed but not saved.
- **pdf.width**  
  Width for the pdf file generated.
- **mar**  
  Margin to use for the plot. See `par`.

**Value**

A set of parallel coordinates plots showing the parameters values. If a filename is provided this plots are saved in one or more files.

**Author(s)**

Manuel López-Ibáñez and Leslie Pérez Cáceres

**See Also**

- `readParameters` to obtain a valid parameter structure from a parameters file.
- `readConfigurationsFile` to obtain a set of target algorithm configurations from a configurations file.

**Examples**

```r
## To use data obtained by irace
# First, load the data produced by irace.
irace.logfile <- file.path(system.file(package="irace"), "exdata", "irace-acotsp.Rdata")
load(irace.logfile)
attach(iraceresults)
parallelCoordinatesPlot(allconfigurations, parameters, hierarchy = FALSE)
```

---

**parameterFrequency**  
*Plot of histogram of parameter values*

**Description**

`parameterFrequency` plots the frequency of the parameters values in a set of target algorithm configurations. It generates plots showing the frequency of parameter values for each parameter, with rows * cols parameters being shown per plot. If a filename is provided the plots are saved in one or more files.
Usage

```
parameterFrequency(configurations, parameters, rows = 4, cols = 3,
                   filename = NULL, pdf.width = 12, col = "gray")
```

Arguments

- `configurations`: Data frame containing target algorithms configurations in the format used by `irace`.
- `parameters`: List of target algorithm parameters in the `irace` format.
- `rows`: Number of plots per column.
- `cols`: Number of plots per row.
- `filename`: Filename prefix to generate the plots. If `NULL` the plot displayed but not saved.
- `pdf.width`: Width for the pdf file generated.
- `col`: Color of the bar plot.

Author(s)

Manuel López-Ibáñez and Leslie Pérez Cáceres

See Also

- `readParameters` to obtain a valid parameter structure from a parameters file.
- `readConfigurationsFile` to obtain a set of target algorithm configurations from a configurations file.

Examples

```
## To use data obtained by irace

# First, load the data produced by irace.
iracelogfile <- file.path(system.file(package="irace"), "exdata", "irace-acotsp.Rdata")
load(iracelogfile)
attach(iraceresults)
parameterFrequency(allConfigurations, parameters)
```

---

**plotAblation**

Create plot from an ablation log

Description

Create plot from an ablation log
**printScenario**

Usage

```
plotAblation(ab.log = NULL, abLogFile = NULL, pdf.file = NULL,
    pdf.width = 20, type = c("mean", "boxplot"), mar = par("mar"),
    ylab = "Mean configuration cost", ...)
```

Arguments

- `ab.log`: Ablation log returned by `ablation`.
- `abLogFile`: Rdata file containing the ablation log.
- `pdf.file`: Output filename.
- `pdf.width`: Width provided to create the pdf file.
- `type`: Type of plots. Supported values are "mean" and "boxplot".
- `mar`: Vector with the margins for the ablation plot.
- `ylab`: Label of y-axis.
- `...`: Further graphical parameters may also be supplied as arguments. See `plot.default`.

Author(s)

Leslie Pérez Cáceres and Manuel López-Ibáñez

See Also

- `ablation`

---

**printScenario**

*Prints the given scenario*

Description

Prints the given scenario

Usage

```
printScenario(scenario)
```

Arguments

- `scenario`: A list where tagged elements correspond to scenario settings of `irace`.

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste
See Also

readScenario for reading a configuration scenario from a file.

printScenario prints the given scenario.

defaultScenario returns the default scenario settings of irace.

checkScenario to check that the scenario is valid.

Description

psRace performs a postselection race a set of configurations.

Usage

psRace(iracelogfile = NULL, iraceresults = NULL, conf.ids = NULL, postselection = NULL, max.experiments = NULL, elites = FALSE, seed = 1234567)

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>iracelogfile</td>
<td>NULL Log file created by irace, this file must contain the iraceresults object.</td>
</tr>
<tr>
<td>iraceresults</td>
<td>NULL Object created by irace and saved in scenario$logfile.</td>
</tr>
<tr>
<td>conf.ids</td>
<td>NULL IDs of the configurations in iraceresults$allConfigurations to be used for ablation. If NULL, the elites argument will be used.</td>
</tr>
<tr>
<td>postselection</td>
<td>NULL Percentage of the maxExperiments provided in the scenario to be used in the race.</td>
</tr>
<tr>
<td>max.experiments</td>
<td>NULL Number of experiments available for the race. If NULL budget for the race is set by the parameter scenario$postselection, which defines the percentage of the total budget of irace (iraceresults$scenario$maxExperiments or iraceresults$scenario$maxTime/iraceresults$state$timeEstimate) to use for the postselection.</td>
</tr>
<tr>
<td>elites</td>
<td>FALSE Flag for selecting configurations. If FALSE, the best configurations of each iteration are used for the race. If TRUE, the elite configurations of each iteration are used for the race.</td>
</tr>
<tr>
<td>seed</td>
<td>1234567 Numerical value to use as seed for the random number generation.</td>
</tr>
</tbody>
</table>


Value

If iraceLogFile is NULL, it returns a list with the following elements:

- **configurations** Configurations used in the race.
- **instances** A matrix with the instances used in the experiments. First column has the instances ids from iraceResults$scenario$instances, second column the seed assigned to the instance.
- **maxExperiments** Maximum number of experiments set for the race.
- **experiments** A matrix with the results of the experiments (columns are configurations, rows are instances).
- **elites** Best configurations found in the experiments.

If iracelogfile is provided this list object will be saved in iraceResults$psrace.log.

Author(s)

Leslie Pérez Cáceres

Examples

```r
## Not run:
# Execute the postselection automatically after irace
parameters <- readParameters("parameters.txt")
scenario <- readScenario(filename="scenario.txt", scenario=defaultScenario())
# Use 10% of the total budget
scenario$postselection <- 0.1
irace(scenario=scenario, parameters=parameters)
# Execute the postselection after the execution of `irace`
psRace(iracelogfile="irace.Rdata", max.experiments=120)
## End(Not run)
```

Description

readConfigurationsFile reads a set of target algorithms configurations from a file and puts them in irace format. The configurations are checked to match the parameters description provided.

Usage

```r
readConfigurationsFile(filename, parameters, debugLevel = 0, text)
```
### Arguments

- **filename**: A filename from which the configurations should be read.
- **parameters**: List of target algorithm parameters in the `irace` format.
- **debugLevel**: Level of debug. Default: 0.
- **text**: (optional) Character string: if file is not supplied and this is, then parameters are read from the value of text via a text connection.

### Value

A data frame containing the obtained configurations. Each row of the data frame is a candidate configuration, the columns correspond to the parameter names in `parameters`.

### Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

### See Also

- `readParameters` to obtain a valid parameter structure from a parameters list.

---

**readParameters**  
*readParameters*

### Description

`readParameters` reads the parameters to be tuned by `irace` from a file or directly from a character string.

### Usage

```r
readParameters(file, digits = 4, debugLevel = 0, text)
```

### Arguments

- **file**: (optional) Character string: the name of the file containing the definitions of the parameters to be tuned.
- **digits**: The number of decimal places to be considered for the real parameters.
- **debugLevel**: Integer: the debug level to increase the amount of output.
- **text**: (optional) Character string: if file is not supplied and this is, then parameters are read from the value of text via a text connection.
Details

Either 'file' or 'text' must be given. If 'file' is given, the parameters are read from the file 'file'. If 'text' is given instead, the parameters are read directly from the 'text' character string. In both cases, the parameters must be given (in 'text' or in the file whose name is 'file') in the expected form. See the documentation for details. If none of these parameters is given, irace will stop with an error.

A fixed parameter is a parameter that should not be sampled but instead should be always set to the only value of its domain. In this function we set isFixed to TRUE only if the parameter is a categorical and has only one possible value. If it is an integer and the minimum and maximum are equal, or it is a real and the minimum and maximum values satisfy \( \text{round}(\text{minimum}, \text{digits}) = \text{round}(\text{maximum}, \text{digits}) \), then the parameter description is rejected as invalid to identify potential user errors.

Value

A list containing the definitions of the parameters read. The list is structured as follows:

- names: Vector that contains the names of the parameters.
- types: Vector that contains the type of each parameter 'i', 'c', 'r', 'o'. Numerical parameters can be sampled in a log-scale with 'i,log' and 'r,log' (no spaces).
- switches: Vector that contains the switches to be used for the parameters on the command line.
- domain: List of vectors, where each vector may contain two values (minimum, maximum) for real and integer parameters, or possibly more for categorical parameters.
- conditions: List of R logical expressions, with variables corresponding to parameter names.
- isfixed: Logical vectors that specifies which parameter is fixed and, thus, it does not need to be tuned.
- nbParameters: An integer, the total number of parameters.
- nbFixed: An integer, the number of parameters with a fixed value.
- nbVariable: Number of variable (to be tuned) parameters.

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

Examples

```r
## Read the parameters directly from text
parameters.table <- '{\text{\texttt{tmax}} "i" (2, 10)}
\text{\texttt{temp}} "r" (10, 50)}
',
parameters <- readParameters(text=parameters.table)
parameters
```
**readScenario**

**Description**

readScenario reads the scenario to be used by **irace** from a file.

**Usage**

```r
readScenario(filename = '', scenario = list())
```

**Arguments**

- `filename`: A filename from which the scenario will be read. If empty, the default scenario file is used. An example scenario file is provided in `system.file(package="irace", "templates/scenario.txt")`.
- `scenario`: A list where tagged elements correspond to scenario settings for **irace**. This is an initial scenario that is overwritten for every parameter specified in the file to be read.

**Value**

The scenario list read from the file. The scenario parameter not present in the file are not present in the list, that is, they are NULL.

**Author(s)**

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

**See Also**

- `printScenario` prints the given scenario.
- `defaultScenario` returns the default scenario settings of **irace**.
- `checkScenario` to check that the scenario is valid.

---

**removeConfigurationsMetaData**

**Description**

Remove the columns with "metadata" of a matrix containing some configuration configurations. These "metadata" are used internally by **irace**. This function can be used e.g. before printing the configurations, to output only the values for the parameters of the configuration without data possibly useless to the user.
scenario.update.paths

Usage

removeConfigurationsMetaData(configurations)

Arguments

configurations A matrix containing the configurations, one per row.

Value

The same matrix without the "metadata".

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

See Also

`configurations.print.command` to print the configurations as command lines. `configurations.print` to print the configurations as a data frame.

---

scenario.update.paths Update filesystem paths of a scenario consistently.

Description

This function should be used to change the filesystem paths stored in a scenario object. Useful when moving a scenario from one computer to another.

Usage

scenario.update.paths(scenario, from, to, fixed = TRUE)

Arguments

scenario list containing `irace` settings. The data structure has to be the one returned by the function `defaultScenario` and `readScenario`.

from character string containing a regular expression (or character string for fixed = TRUE) to be matched.

to the replacement string. character string. For fixed = FALSE this can include backreferences "\1" to "\9" to parenthesized subexpressions of from.

fixed logical. If TRUE, from is a string to be matched as is.

Value

The updated scenario
See Also

grep

Examples

```r
## Not run:
scenario <- readScenario(filename = "scenario.txt")
scenario <- scenario.update.paths(scenario, from = "/home/manuel/", to = "/home/leslie")

## End(Not run)
```

target.evaluator.default

target.evaluator.default

Description

target.evaluator.default is the default targetEvaluator function that is invoked if targetEvaluator is a string (by default targetEvaluator is NULL and this function is not invoked). You can use it as an advanced example of how to create your own targetEvaluator function.

Usage

target.evaluator.default(experiment, num.configurations, all.conf.id, scenario, target.runner.call)

Arguments

- **experiment**: A list describing the experiment. It contains at least:
  - **id.configuration**: An alphanumeric string that uniquely identifies a configuration;
  - **id.instance**: An alphanumeric string that uniquely identifies an instance;
  - **seed**: Seed for the random number generator to be used for this evaluation, ignore the seed for deterministic algorithms;
  - **instance**: String giving the instance to be used for this evaluation;
  - **bound** (only when capping is enabled) Time bound for the execution;
  - **configuration**: 1-row data frame with a column per parameter name;
  - **switches**: Vector of parameter switches (labels) in the order of parameters used in configuration.

- **num.configurations**: Number of configurations alive in the race.

- **all.conf.id**: Vector of configuration IDs of the alive configurations.

- **scenario**: Options passed when invoking irace.

- **target.runner.call**: String describing the call to targetRunner that corresponds to this call to targetEvaluator. This is used for providing extra information to the user, for example, in case targetEvaluator fails.
Value

The function targetEvaluator must return a list with one element "cost", the numerical value corresponding to the cost measure of the given configuration on the given instance.

The return list may also contain the following optional elements that are used by irace for reporting errors in targetEvaluator:

- error is a string used to report an error;
- outputRaw is a string used to report the raw output of calls to an external program or function;
- call is a string used to report how targetRunner called an external program or function.

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

Description

target.runner.default is the default targetRunner function. You can use it as an advanced example of how to create your own targetRunner function.

Usage

target.runner.default(experiment, scenario)

Arguments

- experiment A list describing the experiment. It contains at least:
  id.configuration An alphanumeric string that uniquely identifies a configuration;
  id.instance An alphanumeric string that uniquely identifies an instance;
  seed Seed for the random number generator to be used for this evaluation, ignore the seed for deterministic algorithms;
  instance String giving the instance to be used for this evaluation;
  bound  (only when capping is enabled) Time bound for the execution;
  configuration 1-row data frame with a column per parameter name;
  switches Vector of parameter switches (labels) in the order of parameters used in configuration.

- scenario Options passed when invoking irace.
testConfigurations

Value

If `targetEvaluator` is NULL, then the `targetRunner` function must return a list with at least one element "cost", the numerical value corresponding to the evaluation of the given configuration on the given instance.

If the scenario option `maxTime` is non-zero or if capping is enabled then the list must contain at least another element "time" that reports the execution time for this call to `targetRunner`. The return list may also contain the following optional elements that are used by `irace` for reporting errors in `targetRunner`:

- `error` is a string used to report an error;
- `outputRaw` is a string used to report the raw output of calls to an external program or function;
- `call` is a string used to report how `targetRunner` called an external program or function.

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

Description

testConfigurations executes the given configurations on the testing instances specified in the scenario.

Usage

testConfigurations(configurations, scenario, parameters)

Arguments

- `configurations` a data frame containing the configurations (one per row).
- `scenario` Data structure containing `irace` settings. The data structure has to be the one returned by the function `defaultScenario` and `readScenario`.
- `parameters` A data structure similar to that provided by the `readParameters` function.

Details

A test instance set must be provided through `scenario$testInstances`.

Value

A list with the following elements:

- `experiments` Experiments results.
- `seeds` Array of the instance seeds used in the experiments.
Author(s)

Manuel López-Ibáñez

See Also

testing.main

Description

testing.main executes the testing of the target algorithm configurations found on an irace execution.

Usage

testing.main(logFile)

Arguments

logFile Path to the .Rdata file produced by irace.

Details

The function testing.main loads the logFile and obtains the needed configurations according to the specified test. Use the scenario$test NbElites to test N final elite configurations or use scenario$testIterationElites to test the best configuration of each iteration. A test instance set must be provided through scenario$testInstancesDir and testInstancesFile.

Value

Boolean. TRUE if the testing ended successfully otherwise, returns FALSE.

Author(s)

Manuel López-Ibáñez and Leslie Pérez Cáceres

See Also

defaultScenario to provide a default scenario for irace.
# Index

+ **Topic** automatic
  - `irace-package`, 2
+ **Topic** configuration
  - `irace-package`, 2
+ **Topic** datasets
  - `irace-license`, 20
  - `irace.version`, 22
+ **Topic** optimize
  - `irace-package`, 2
+ **Topic** package
  - `irace-package`, 2
+ **Topic** tuning
  - `irace-package`, 2

ablation, 5, 25

buildCommandLine, 7

checkIraceScenario, 8
checkScenario, 9, 9, 15, 19, 26, 30
configurations.print, 10, 11, 31
configurations.print.command, 10, 10, 31
configurationsBoxplot, 11

defaultScenario, 8, 9, 12, 15, 18, 19, 21, 26, 30, 31, 34, 35

getAddressByCommand, 9
getConfigurationById, 16
getConfigurationByIteration, 16
getFinalElites, 17
grep, 32

irace, 18, 21
irace-package, 2
irace.cmdline, 20, 21
irace.license, 20
irace.main, 3, 19, 20, 21
irace.usage, 22
irace.version, 22

par, 23

parallelCoordinatesPlot, 22
parameterFrequency, 22
plotAblation, 24
printScenario, 9, 15, 25, 26, 30
psRace, 26

readConfigurationsFile, 23, 24, 27
readParameters, 8, 10, 18, 19, 23, 24, 28, 28, 34
readScenario, 8, 9, 15, 18–21, 26, 30, 31, 34
removeConfigurationsMetaData, 16, 17, 30

scenario.update.paths, 31

target.evaluator.default, 32
target.runner.default, 33
testConfigurations, 34
testing.main, 35, 35