Package ‘irace’

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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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License GPL (>= 2)

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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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The irace package: 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.
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

### 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:

```r
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_rastrigin(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
```r
ablation

## target.runner.
checkIraceScenario(scenario, parameters = parameters)

## We are now ready to launch irace. We do it by means of the irace
## function. The function will print information about its
## progress. This may require a few minutes, so it is not run by default.
tuned.conf's <- irace(scenario = scenario, parameters = parameters)

## We can print the best configurations found by irace as follows:
configurations.print(tuned.conf's)

## We can evaluate the quality of the best configuration found by
## irace versus the default configuration of the SANN algorithm on
## the other 100 instances previously generated.
## To do so, first we apply the default configuration of the SANN
## algorithm to these instances:
test <- function(configuration)
{
  res <- lapply(weights[101:200],
    function(x) target.runner(
      experiment = list(instance = x,
        configuration = configuration),
      scenario = scenario))
  return (sapply(res, getElement, name = "cost"))
}
default <- test(data.frame(tmax=10, temp=10))
## We extract and apply the winning configuration found by irace
## to these instances:
tuned <- test (removeConfigurationsMetaData(tuned.conf's[1,,])

## Finally, we can compare using a boxplot the quality obtained with the
## default parametrization of SANN and the quality obtained with the
## best configuration found by irace.
boxplot(list(default = default, tuned = tuned))
```

---

**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 `scenario$logfile`.
- `src`, `target`: Source and target configuration IDs. If `NULL`, then the first configuration ever evaluated is used as source and the best configuration found is used as target.
- `ab.params`: Parameter names to be used for the ablation. They must be in `parameters$names`.
- `n.instances`: Number of instances to be used for the "full" ablation, if not provided first `test` 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 `debugLevel` 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

**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**

```r
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 between each pair of parameters (but none between the switches and the corresponding values).

**Author(s)**

Manuel López-Ibáñez and Jérémie Dubois-Lacoste
Examples

```
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

```
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.

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste
**checkScenario**

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**

`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 command

Print configurations as a data frame

Description
Print configurations as a data frame

Usage
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
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.

---

configurationsBoxplot Creates box plots of the quality of configurations.

Description
Creates box plots of the quality of configurations.

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

Arguments

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>experiments</td>
<td>Matrix of performance of configurations (columns) over a set of instances (rows).</td>
</tr>
<tr>
<td>title</td>
<td>(NULL) Title for the plot.</td>
</tr>
<tr>
<td>xlabel</td>
<td>Label for the x axis.</td>
</tr>
<tr>
<td>ylabel</td>
<td>Label for the y axis.</td>
</tr>
<tr>
<td>filename</td>
<td>(NULL) Filename prefix to create a pdf file with the plot.</td>
</tr>
</tbody>
</table>

Value
Box plot of the performance of the configurations.

Author(s)
Manuel López-Ibáñez and Leslie Pérez Cáceres
defaultScenario  

**Default scenario settings**

**Description**
Return scenario with default values.

**Usage**
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)

- **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:

dataFile 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 performed. 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 computation 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 multiple comparisons). (Default: "F-test")

`firstTest` Number of instances evaluated before the first elimination test. It must be a multiple 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 computation 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.

getConfigurationById  Returns the configurations selected by ID.
getConfigurationByIteration

Usage

getConfigurationByIteration(iraceresults = NULL, logfile = NULL, ids, 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.
ids 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

getConfigurationByIteration

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

Description

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

Usage

getConfigurationByIteration(iraceresults = NULL, logfile = NULL, iterations, drop.metadata = FALSE)

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.
getFinalElites

Author(s)
Manuel López-Ibáñez and Leslie Pérez Cáceres

getFinalElites
Return the elite configurations of the final iteration.

Description
Return the elite configurations of the final iteration.

Usage
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

irace

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 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 allConfigurations$.ID.).
iterationElites A vector containing the best candidate configuration internal identifier of each iteration. The best configuration found corresponds to the last one of this vector.
experiments A matrix with configurations as columns and instances as rows. Column names correspond to the internal identifier of the configuration (allConfigurations$.ID.).
experimentLog A matrix with columns iteration, instance, configuration, time. This matrix contains the log of all the experiments that irace performs during its execution. The instance column refers to the index of the 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 FALSE, then no soft restart was performed.

state A list that contains the state of 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.

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

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

Examples

```r
## Not run:
parameters <- readParameters("parameters.txt")
scenario <- readScenario(filename = "scenario.txt",
                         scenario = defaultScenario())
irace(scenario = scenario, parameters = parameters)

## End(Not run)
```

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

Usage
irace.cmdline(args = commandArgs(trailingOnly = TRUE))

Arguments

<table>
<thead>
<tr>
<th>arg</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>args</td>
<td>commandArgs(trailingOnly = TRUE) The arguments provided on the R command line as a character vector, e.g., c(&quot;--scenario&quot;, &quot;scenario.txt&quot;, &quot;-p&quot;, &quot;parameters.txt&quot;). Using the default value (not providing the parameter) is the easiest way to call irace.cmdline.</td>
</tr>
</tbody>
</table>
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

irace.license

Format

An object of class character of length 1.

irace.main

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 `iraceNmain` 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 `iraceNmain`. `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.
parallelCoordinatesPlot

**Description**

`parallelCoordinatesPlot` plots a set of parameter configurations in parallel coordinates.

**Usage**

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

**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)
```

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

```r
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

```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)
parameterFrequency(allConfigurations, parameters)
```

---

`plotAblation` Create plot from an ablation log

**Description**

Create plot from an ablation log

**Usage**

```r
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

*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.

---

psRace

*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

- **iraceLogFile**: NULL Log file created by `irace`, this file must contain the `iraceResults` object.
- **iraceResults**: NULL Object created by `irace` and saved in `scenario$logFile`.
- **conf.ids**: NULL IDs of the configurations in `iraceResults$allConfigurations` to be used for ablation. If NULL, the `elites` argument will be used.
- **postselection**: NULL Percentage of the `maxExperiments` provided in the `scenario` to be used in the race.
- **max.experiments**: 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.
- **elites**: 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.
- **seed**: 1234567 Numerical value to use as seed for the random number generation.

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 \pkg{irace}.
```
readConfigurationsFile

Description

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

Usage


readConfigurationsFile(filename, parameters, debugLevel = 0, text)

Arguments

- \texttt{filename}: A filename from which the configurations should be read.
- \texttt{parameters}: List of target algorithm parameters in the \textit{irace} format.
- \texttt{debugLevel}: Level of debug. Default: 0.
- \texttt{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 \texttt{parameters}.

Author(s)

Manuel López-Ibáñez and Jérémie Dubois-Lacoste

See Also

\texttt{readParameters} to obtain a valid parameter structure from a parameters list.
**Description**

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

**Usage**

`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 'round(minimum, digits) == round(maximum, 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:

- **namesVector** that contains the names of the parameters.
- **typesVector** 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).
- **switchesVector** that contains the switches to be used for the parameters on the command line.
- **domainList** 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
```
## Read the parameters directly from text
parameters.table <- c("tmax" i (2, 10)
          temp "r" (10, 50)
          
          parameters <- readParameters(text=parameters.table)
          parameters
```

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

Usage
```
readScenario(filename = "", scenario = list())
```

Arguments
- filename: A filename from which the scenario will be read. If empty, the default scenarioFile
  is used. An example scenario file is provided in system.file(package="irace", "templates/scenario"
- 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.

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.

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.
**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: 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.

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.
testConfigurations

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

testConfigurations  testConfigurations

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 link{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 load the logfile and obtains the needed configurations according to the specified test. Use the scenario$testNbElites to test N final elite configurations or use scenario$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.
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