Package ‘SimEngine’

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Author Avi Kenny [aut, cre], Charles Wolock [aut]
Maintainer Avi Kenny <avi.kenny@gmail.com>
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get_complex

Access internal simulation variables

Description

Extract complex simulation data from a simulation object

Usage

get_complex(sim, sim_uid)

Arguments

- **sim**: A simulation object of class `sim_obj`, usually created by `new_sim`
- **sim_uid**: The unique identifier of a single simulation replicate. This corresponds to the `sim_uid` column in `sim$results`.

Value

The value of the complex simulation result data corresponding to the supplied `sim_uid`

Examples

```r
sim <- new_sim()
create_data <- function(n) {
  x <- runif(n)
  y <- 3 + 2*x + rnorm(n)
  return(data.frame("x"=x, "y"=y))
}
sim %<>% set_levels("n"=c(10, 100, 1000))
sim %<>% set_config(num_sim=1)
sim %<>% set_script(function() {
  dat <- create_data(L$n)
  model <- lm(y~x, data=dat)
  return (list(
    "beta1_hat" = model$coefficients[[2]],
    ".complex" = model
  ))
})
sim %<>% run()
```
js_support

Display information about currently-supported job schedulers

Description

Run this function to display information about job schedulers that are currently supported for running SimEngine simulations on a cluster computing system (CCS).

Usage

js_support()

Examples

js_support()

new_sim

Create a new simulation object

Description

Create a new simulation object. This is typically the first function to be called when running a simulation using SimEngine. Most other SimEngine functions take a simulation object as their first argument.

Usage

new_sim()

Value

A simulation object, of class sim_obj

See Also

Visit https://avi-kenny.github.io/SimEngine/ for more information on how to use the SimEngine simulation framework.

Examples

sim <- new_sim()
sim
run

Run the simulation

Description

This is the workhorse function of SimEngine that actually runs the simulation. This should be called after all functions that set up the simulation (set_config, set_script, etc.) have been called.

Usage

run(sim, sim_uids = NA)

Arguments

sim A simulation object of class sim_obj, usually created by new_sim

sim_uids Advanced; a vector of sim_uid values, each of which uniquely identifies a simulation replicate. This will normally be omitted. If this is specified, only the simulation replicates with a matching sim_uid will be run.

Value

The original simulation object but with the results attached (along with any errors and warnings). Results are stored in sim$results, errors are stored in sim$errors, and warnings are stored in sim$warnings.

Examples

# The following is a toy example of a simulation, illustrating the use of
# the run function.
sim <- new_sim()
create_data <- function(n) { rpois(n, lambda=5) }
est_mean <- function(dat, type) {
  if (type=="M") { return(mean(dat)) }
  if (type=="V") { return(var(dat)) }
}
sim %<>% set_levels(n=c(10,100,1000), est=c("M","V"))
sim %<>% set_config(num_sim=1)
sim %<>% set_script(function() {
  dat <- create_data(L$n)
  lambda_hat <- est_mean(dat=dat, type=L$est)
  return (list("lambda_hat"=lambda_hat))
})
sim %<>% run()
sim$results %>% print()
Description

This function serves a scaffold for running simulations in parallel on a cluster computing system. It acts as a wrapper for the code in your simulation script, organizing the code into three sections, labeled "first" (code that is run once at the start of the simulation, e.g. setting simulation levels), "main" (the simulation script, which is run repeatedly), and "last" (code to combine and summarize simulation results). This function interacts with cluster job scheduler software (e.g. Slurm or Oracle Grid Engine) to divide parallel tasks over cluster nodes. See https://avi-kenny.github.io/SimEngine/parallelization/ for an overview of how cluster parallelization works in SimEngine.

Usage

run_on_cluster(first, main, last, cluster_config)

Arguments

first Code to run at the start of a simulation. This should be a block of code enclosed by curly braces that creates a simulation object. Put everything you need in the simulation object, since global variables declared in this block will not be available when the 'main' and 'last' code blocks run.

main Code that will run for every simulation replicate. This should be a block of code enclosed by curly braces that includes a call to run. This code block will have access to the simulation object you created in the 'first' code block, but any changes made here to the simulation object will not be saved.

last Code that will run after all simulation replicates have been run. This should be a block of code enclosed by curly braces that takes your simulation object (which at this point will contain your results) and do something with it, such as display your results on a graph.

cluster_config A list of configuration options. You must specify either js (the job scheduler you are using) or tid_var (the name of the environment variable that your task ID is stored in). Run js_support() to see a list of job schedulers that are currently supported. You can optionally also specify dir, which is a character string representing a path to a directory; this directory will serve as your working directory and hold your simulation object, temporary SimEngine objects, and simulation results (this defaults to the working directory of the R script that contains your simulation code).

Examples

```r
## Not run:
# The following is a toy simulation that could be run on a cluster computing
# environment. It runs 10 replicates of 2 simulation levels as 20 separate
```
set_config

Modify the simulation configuration

Description

This function sets configuration options for the simulation. If the 'packages' argument is specified, all packages will be loaded and attached via library when set_config is called. Multiple calls
to `set_config` will only overwrite configuration options that are specified in the subsequent calls, leaving others in place. You can see the current configuration via `print(sim)`, where `sim` is your simulation object.

Usage

```r
set_config(
  sim,
  num_sim = 1000,
  parallel = "none",
  n_cores = parallel::detectCores() - 1,
  packages = NULL,
  stop_at_error = FALSE,
  progress_bar = TRUE,
  seed = NA
)
```

Arguments

- `sim` A simulation object of class `sim_obj`, usually created by `new_sim`
- `num_sim` An integer; the number of simulations to conduct for each level combination
- `parallel` A string; one of c("outer", "inner", "none"). Controls which sections of the code are parallelized. Setting to "outer" will run one simulation per core. Setting to "inner" will allow for parallelization within a single simulation replicate. Setting to "none" will not parallelize any code. See [https://avi-kenny.github.io/SimEngine/parallelization/](https://avi-kenny.github.io/SimEngine/parallelization/) for an overview of how parallelization works in `SimEngine`. This option will be ignored if the simulation is being run on a cluster computing system.
- `n_cores` An integer; determines the number of CPUs on which the simulation will run if using parallelization. Defaults to one fewer than the number of available CPUs on the current host.
- `packages` A character vector of packages to load and attach
- `stop_at_error` A Boolean. If set to TRUE, the simulation will stop if it encounters an error in any single replicate. Useful for debugging.
- `progress_bar` A Boolean. If set to FALSE, the progress bar that is normally displayed while the simulation is running is suppressed.
- `seed` An integer; seeds allow for reproducible simulation results. If a seed is specified, then consecutive runs of the same simulation with the same seed will lead to identical results (under normal circumstances). If a seed was not set in advance by the user, `SimEngine` will set a random seed, which can later be retrieved using the `vars` function. See details for further info.

Details

- If a user specifies, for example, `set_config(seed=4)`, this seed is used twice by `SimEngine`. First, `SimEngine` executes `set.seed(4)` at the end of the `set_config` call. Second, this seed is used to generate a new set of seeds, one for each simulation replicate. Each of these seeds is set in turn (or in parallel) when `run` is called.
• Even if seeds are used, not all code will be reproducible. For example, a simulation that involves getting the current date/time with `Sys.time()` or dynamically retrieving external data may produce different results on different runs.

Value

The original simulation object with a modified configuration

Examples

```r
sim <- new_sim()
sim %<>% set_config(
  num_sim = 10,
  seed = 2112
)
sim
```

---

**set_levels**

*Set simulation levels*

Description

Set one or more simulation levels, which are things that vary between simulation replicates.

Usage

```r
set_levels(sim, ..., .add = FALSE, .keep = NA)
```

Arguments

- `sim` A simulation object of class `sim_obj`, usually created by `new_sim`
- `...` One or more key-value pairs representing simulation levels. Each value can either be a vector (for simple levels) or a list of lists (for more complex levels). See examples.
- `.add` Only relevant if `set_levels` is called twice or more. On the second call, if `add=FALSE` (default) the old set of levels will be replaced by the new set, whereas if `add=TRUE` the new set of levels will be merged with the old set. See examples.
- `.keep` An integer vector specifying which level combinations to keep; see examples.

Value

The original simulation object with the old set of levels replaced with the new set
set_script

Examples

# Basic usage is as follows:
sim <- new_sim()
sim %<>% set_levels(
   "n" = c(10, 100, 1000),
   "theta" = c(2, 3)
)
sim$levels

# More complex levels can be set using lists:
sim %<>% set_levels(
   "n" = c(10, 100, 1000),
   "theta" = c(2, 3),
   "method" = list(
      "spline1" = list(knots=c(2,4), slopes=c(0.1,0.4)),
      "spline2" = list(knots=c(1,5), slopes=c(0.2,0.3))
   )
)
sim$levels

# By default, set_levels will overwrite old levels if it is called twice:
sim %<>% set_levels(alpha=c(1,2), beta=c(5,6))
sim %<>% set_levels(alpha=c(3,4), gamma=c(7,8))
sim$levels

# To merge the old levels with the new levels instead, specify .add=TRUE:
sim %<>% set_levels(alpha=c(1,2), beta=c(5,6))
sim %<>% set_levels(alpha=c(3,4), gamma=c(7,8), .add=TRUE)
sim$levels

# If you don't want to run simulations for all level combinations, use the
# .keep option. First, set the levels normally. Second, view the
# sim$levels_grid dataframe to examine the level combinations and the
# associated level_id values. Third, call set_levels again with the .keep
# option to specify which levels to keep (via a vector of level_id values).
sim %<>% set_levels(alpha=c(1,2,3), beta=c(5,6))
sim$levels_grid
sim %<>% set_levels(.keep=c(1,2,6))
sim$levels_grid

---

set_script

Set the "simulation script"

Description

Specify a function to be used as the "simulation script". The simulation script is a function that runs
a single simulation replicate and returns the results.

Usage

set_script(sim, fn)
Arguments

**sim**  
A simulation object of class `sim_obj`, usually created by `new_sim`

**fn**  
A function that runs a single simulation replicate and returns the results. The results must be a list of key-value pairs. Values are categorized as simple (a number, a character string, etc.) or complex (vectors, dataframes, lists, etc.). Complex data must go inside a key called ".complex" and the associated value must be a list (see examples). The function body can contain references to the special object `L` that stores the current set of simulation levels (see examples). The keys must be valid R names (see `?make.names`).

Value

The original simulation object with the new "simulation script" function added.

Examples

```r
# The following is a toy example of a simulation, illustrating the use of  
# the set_script function.
sim <- new_sim()
create_data <- function(n) { rpois(n, lambda=5) }
est_mean <- function(dat, type) {
  if (type=="M") { return(mean(dat)) }  
  if (type=="V") { return(var(dat)) }
}
sim %<>% set_levels(n=c(10,100,1000), est=c("M","V"))
sim %<>% set_config(num_sim=1)
sim %<>% set_script(function() {
  dat <- create_data(L$n)
  lambda_hat <- est_mean(dat=dat, type=L$est)
  return (list("lambda_hat"=lambda_hat))
})
sim %<>% run()
sim$results
```

```r
# If you need to return complex result data (vectors, dataframes, lists,  
# etc.), use the construct ".complex"=list().
sim <- new_sim()
sim %<>% set_levels(n=c(4,9))
sim %<>% set_config(num_sim=1)
sim %<>% set_script(function() {
  dat <- rnorm(L$n)
  mtx <- matrix(dat, nrow=sqrt(length(dat)))
  return (list(  
    "mean" = mean(dat),  
    "det" = det(mtx),  
    ".complex" = list(dat=dat, mtx=mtx)  
  ))
})
sim %<>% run()
```
SimEngine: A modular framework for statistical simulations in R

Description

SimEngine is an open-source R package for structuring, maintaining, running, and debugging statistical simulations on both local and cluster-based computing environments. Emphasis is placed on thorough documentation and scalability.

Documentation

The primary documentation for SimEngine is housed at https://avi-kenny.github.io/SimEngine/ - we recommend that users start here when first learning how to use the package. Additionally, standard R documentation is provided, which can be accessed in the usual way (e.g. ?new_sim).

summarize

Summarize simulation results

Description

This function calculates summary statistics for simulation results. Options for summary statistics include descriptive statistics (e.g. measures of center or spread) and inferential statistics (e.g. bias or confidence interval coverage). All summary statistics are calculated over simulation replicates within a single simulation level.

Usage

summarize(sim, ...)

Arguments

sim

A simulation object of class sim_obj, usually created by new_sim

... Name-value pairs of summary statistic functions. The possible functions (names) are listed below. The value for each summary function is a list of summaries to perform.

- mean: Each mean summary is a named list of three arguments. name gives a name for the summary, x gives the name of the variable in sim$results on which to calculate the mean, and na.rm indicates whether to exclude NA values when performing the calculation.

- median: Each median summary is a named list of three arguments. name gives a name for the summary, x gives the name of the variable in sim$results on which to calculate the median, and na.rm indicates whether to exclude NA values when performing the calculation.
• **var**: Each var (variance) summary is a named list of three arguments. *name* gives a name for the summary, *x* gives the name of the variable in `sim$results` on which to calculate the variance, and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **sd**: Each sd (standard deviation) summary is a named list of three arguments. *name* gives a name for the summary, *x* gives the name of the variable in `sim$results` on which to calculate the standard deviation, and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **mad**: Each mad (mean absolute deviation) summary is a named list of three arguments. *name* gives a name for the summary, *x* gives the name of the variable in `sim$results` on which to calculate the MAD, and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **iqr**: Each iqr (interquartile range) summary is a named list of three arguments. *name* gives a name for the summary, *x* gives the name of the variable in `sim$results` on which to calculate the IQR, and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **min**: Each min (minimum) summary is a named list of three arguments. *name* gives a name for the summary, *x* gives the name of the variable in `sim$results` on which to calculate the minimum, and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **max**: Each max (maximum) summary is a named list of three arguments. *name* gives a name for the summary, *x* gives the name of the variable in `sim$results` on which to calculate the maximum, and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **quantile**: Each quantile summary is a named list of four arguments. *name* gives a name for the summary, *x* gives the name of the variable in `sim$results` on which to calculate the quantile, *prob* is a number in [0,1] denoting the desired quantile, and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **bias**: Each bias summary is a named list of four arguments. *name* gives a name for the summary, *estimate* gives the name of the variable in `sim$results` containing the estimator of interest, *truth* is the estimand of interest (see Details), and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **bias_pct**: Each bias_pct summary is a named list of four arguments. *name* gives a name for the summary, *estimate* gives the name of the variable in `sim$results` containing the estimator of interest, *truth* is the estimand of interest (see Details), and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **mse**: Each mse (mean squared error) summary is a named list of four arguments. *name* gives a name for the summary, *estimate* gives the name of the variable in `sim$results` containing the estimator of interest, *truth* is the estimand of interest (see Details), and *na.rm* indicates whether to exclude NA values when performing the calculation.

• **mae**: Each mae (mean absolute error) summary is a named list of four arguments. *name* gives a name for the summary, *estimate* gives the name of the variable in `sim$results` containing the estimator of interest, *truth* is the
estimand of interest (see Details), and na.rm indicates whether to exclude
NA values when performing the calculation.

• coverage: Each coverage (confidence interval coverage) summary is a
named list of five arguments. Either (estimate, se) or (lower, upper)
must be provided. name gives a name for the summary, estimate gives the
name of the variable in sim$results containing the estimator of interest,
se gives the name of the variable in sim$results containing the standard
error of the estimator of interest, lower gives the name of the variable in
sim$results containing the confidence interval lower bound, upper gives
the name of the variable in sim$results containing the confidence interval
upper bound, truth is the estimand of interest, and na.rm indicates whether
to exclude NA values when performing the calculation. See Details.

Details

• For all summaries besides coverage, the name argument is optional. If name is not provided,
a name will be formed from the type of summary and the column on which the summary is
performed.

• For all inferential summaries there are three ways to specify truth: (1) a single number,
meaning the estimand is the same across all simulation replicates and levels, (2) a numeric
vector of the same length as the number of rows in sim$results, or (3) the name of a variable
in sim$results containing the estimand of interest.

• There are two ways to specify the confidence interval bounds for coverage. The first is to
provide an estimate and its associated se (standard error). These should both be variables
in sim$results. The function constructs a 95% Wald-type confidence interval of the form
(estimate - 1.96 se, estimate + 1.96 se). The alternative is to provide lower and upper
bounds, which should also be variables in sim$results. In this case, the confidence interval
is (lower, upper). The coverage is simply the proportion of simulation replicates for a given
level in which truth lies within the interval.

Value

A data frame containing the result of each specified summary function as a column, for each of the
simulation levels.

Examples

# The following is a toy example of a simulation, illustrating the use of
# the summarize function.
sim <- new_sim()
create_data <- function(n) { rpois(n, lambda=5) }
est_mean <- function(dat, type) {
  if (type=="M") { return(mean(dat)) }
  if (type=="V") { return(var(dat)) }
}
sim %<>% set_levels(n=c(10,100,1000), est=c("M","V"))
sim %<>% set_config(num_sim=5)
sim %<>% set_script(function() {
  dat <- create_data(L$n)
update_sim

Update a simulation

Description

This function updates a previously run simulation. After a simulation has been run, you can alter the levels of the resulting object of class sim_obj using set_levels, or change the configuration (including the number of simulation replicates) using set_config. Executing update_sim on this simulation object will only run the added levels/replicates, without repeating anything that has already been run.

Usage

update_sim(sim, keep_errors = TRUE, keep_extra = FALSE)

Arguments

sim A simulation object of class sim_obj, usually created by new_sim, that has already been run by the run function
keep_errors logical (TRUE by default); if TRUE, do not try to re-run simulation reps that results in errors previously; if FALSE, attempt to run those reps again
keep_extra logical (FALSE by default); if TRUE, keep previously run simulation reps even if they exceed the current num_sim in config or are from a level that has been dropped; if FALSE, drop excess reps (starting from the last rep for that particular simulation level)

Details

- It is not possible to add new level variables, only new levels of the existing variables. Because of this, it is best practice to include all potential level variables before initially running a simulation, even if some of them only contain a single level. This way, additional levels can be added later.
- In general, if num_sim has been reduced prior to running update_sim, it is best to use the default option keep_extra = FALSE. Otherwise, some simulation levels will have more replicates than others, which makes comparison difficult.

Value

The original simulation object with additional simulation replicates in results or errors
Examples

```r
sim <- new_sim()
create_data <- function(n) { rpois(n, lambda=5) }
est_mean <- function(dat, type) {
  if (type=="M") { return(mean(dat)) }
  if (type=="V") { return(var(dat)) }
}
sim %<>% set_levels(n=c(10,100), est="M")
sim %<>% set_config(num_sim=10)
sim %<>% set_script(function() {
  dat <- create_data(L$n)
  lambda_hat <- est_mean(dat=dat, type=L$est)
  return (list("lambda_hat"=lambda_hat))
})
sim %<>% run()
sim %<>% set_levels(n=c(10,100,1000), est=c("M","V"))
sim %<>% set_config(num_sim=5)
sim %<>% update_sim()
```

Description

This function serves a scaffold for updating a previously-run in parallel on a cluster computing system. Like `run_on_cluster`, it acts as a wrapper for the code in your simulation script, organizing the code into three sections, labeled "first" (code that is run once at the start of the simulation, e.g. setting simulation levels), "main" (the simulation script, which is run repeatedly), and "last" (code to combine and summarize simulation results). This function interacts with cluster job scheduler software (e.g. Slurm or Oracle Grid Engine) to divide parallel tasks over cluster nodes. See [https://avi-kenny.github.io/SimEngine/parallelization/](https://avi-kenny.github.io/SimEngine/parallelization/) for an overview of how cluster parallelization works in `SimEngine`.

Usage

```r
update_sim_on_cluster(first, main, last, cluster_config, keep_errors = TRUE, keep_extra = FALSE)
```

Arguments

- `first` Code to run before executing additional simulation replicates. For example, this could include altering the simulation levels or changing `nsim`. This block of
code, enclosed by curly braces, must first read in an existing simulation object and then make alterations to it. Global variables declared in this block will not be available when the 'main' and 'last' code blocks run.

main

Code that will run for every simulation replicate. This should be a block of code enclosed by curly braces that includes a call to update_sim. This code block will have access to the simulation object you read in the 'first' code block, but any changes made here to the simulation object will not be saved.

last

Code that will run after all additional simulation replicates have been run. This should be a block of code enclosed by curly braces that takes your simulation object (which at this point will contain both your old and new results) and do something with it, such as display your results on a graph.

cluster_config

A list of configuration options. You must specify either js (the job scheduler you are using) or tid_var (the name of the environment variable that your task ID is stored in). Run js_support() to see a list of job schedulers that are currently supported. You can optionally also specify dir, which is a character string representing a path to a directory; this directory will serve as your working directory and hold your simulation object, temporary SimEngine objects, and simulation results (this defaults to the working directory of the R script that contains your simulation code).

keep_errors

logical (TRUE by default); if TRUE, do not try to re-run simulation reps that results in errors previously; if FALSE, attempt to run those reps again

keep_extra

logical (FALSE by default); if TRUE, keep previously run simulation reps even if they exceed the current num_sim in config or are from a level that has been dropped; if FALSE, drop excess reps (starting from the last rep for that particular simulation level)

Examples

## Not run:
# The following code creates, runs, and subsequently updates a toy simulation
# on a cluster computing environment. We include both the R code as well as
# sample BASH code for running the simulation using Oracle Grid Engine.

# This code is saved in a file called my_simulation.R
library(SimEngine)
run_on_cluster(

  first = {
    sim <- new_sim()
    create_data <- function(n) { rnorm(n) }
    sim %<>% set_script(function() {
      data <- create_data(L$n)
      return(mean(data))
    })
    sim %<>% set_levels(n=c(100,1000))
    sim %<>% set_config(num_sim=10)
  },

  main = {

    # main code goes here

  },

  last = {

    # last code goes here

  }

)
update_sim_on_cluster

    sim %<>% run()
    ),

    last = {
        sim %<>% summarize()
    },

    cluster_config = list(js="ge")
}

# This code is saved in a file called run_sim.sh
# #!/bin/bash
# Rscript my_simulation.R

# The following lines of code are run on the cluster head node.
# qsub -v sim_run='first' run_sim.sh
# qsub -v sim_run='main' -t 1-20 -hold_jid 101 run_sim.sh
# qsub -v sim_run='last' -hold_jid 102 run_sim.sh

# This code is saved in a file called update_my_simulation.R. Note that it
# reads in the simulation object created above, which is saved in a file
# called "sim.rds".
library(SimEngine)
update_sim_on_cluster(

    first = {
        sim <- readRDS("sim.rds")
        sim %<>% set_levels(n = c(100, 500, 1000))
    },

    main = {
        sim %<>% update_sim()
    },

    last = {
        sim %<>% summarize()
    },

    cluster_config = list(js="ge")
}

# This code is saved in a file called update_sim.sh
# #!/bin/bash
# Rscript update_my_simulation.R

# The following lines of code are run on the cluster head node. Note that
# only 10 new replicates are run, since 20 of 30 simulation replicates were
# run in the original call to run_on_cluster.
# qsub -v sim_run='first' update_sim.sh
# qsub -v sim_run='main' -t 1-10 -hold_jid 104 update_sim.sh
# qsub -v sim_run='last' -hold_jid 105 update_sim.sh
use_method

Use a method

Description

This function calls the specified method, passing along any arguments that have been specified in args. It will typically be used in conjunction with the special object L to dynamically run methods that have been included as simulation levels. This function is a wrapper around do.call and is used in a similar manner. See examples.

Usage

use_method(method, args = list())

Arguments

method A character string naming a function that has been declared or loaded via source().
args A list of arguments to be passed onto method

Value

The result of the call to method

Examples

# The following is a toy example of a simulation, illustrating the use of # the use_method function.
sim <- new_sim()
create_data <- function(n) { rpois(n, lambda=5) }
est_mean_1 <- function(dat) { mean(dat) }
est_mean_2 <- function(dat) { var(dat) }
sim %<>% set_levels("n" = c(10, 100, 1000),
"estimator" = c("est_mean_1", "est_mean_2")
)
sim %<>% set_config(num_sim=1)
sim %<>% set_script(function() {
dat <- create_data(L$n)
lambda_hat <- use_method(L$estimator, list(dat))
return (list("lambda_hat"=lambda_hat))
})
sim %<>% run()
sim$results
vars

Access internal simulation variables

Description

This is a "getter function" that returns the value of an internal simulation variable. Do not change any of these variables manually.

Usage

vars(sim, var)

Arguments

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>sim</td>
<td>A simulation object of class sim_obj, usually created by new_sim</td>
</tr>
<tr>
<td>var</td>
<td>If this argument is omitted, vars() will return a list containing all available internal variables. If this argument is provided, it should equal one of the following character strings:</td>
</tr>
<tr>
<td></td>
<td>• seed: the simulation seed; see set_config for more info on seeds.</td>
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<td></td>
<td>• env: a reference to the environment in which individual simulation replicates are run (advanced)</td>
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<td></td>
<td>• num_sim_total: The total number of simulation replicates for the simulation. This is particularly useful when a simulation is being run in parallel on a cluster computing system as a job array and the user needs to know the range of task IDs.</td>
</tr>
<tr>
<td></td>
<td>• run_state: A character string describing the &quot;run state&quot; of the simulation. This will equal one of the following: &quot;pre run&quot; (the simulation has not yet been run), &quot;run, no errors&quot; (the simulation ran and had no errors), &quot;run, some errors&quot; (the simulation ran and had some errors), &quot;run, all errors&quot; (the simulation ran and all replicates had errors).</td>
</tr>
</tbody>
</table>

Details

• You can also access simulation variables through sim$vars, where sim is your simulation object (see examples).

Value

The value of the internal variable.

Examples

```r
sim <- new_sim()
sim %<>% set_levels(
  "n" = c(10, 100, 1000)
)
sim %<>% set_config(num_sim=10)
```
vars(sim, "num_sim_total") %>% print()

sim$vars$num_sim_total %>% print()

vars(sim) %>% print()
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