Package 'GSA.UN'

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Type Package

Title Global Sensitivity Analysis Tool

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Description A tool to sensitivity analysis using SOBOL (Sobol, 1993) and AMA (Dell'Oca et al. 2017 <doi:10.5194/hess-21-6219-2017>) indices.
It allows to identify the most sensitive parameter or parameters of a model.

Depends R (>= 3.4)

Imports stats, e1071, utils

Suggests knitr, rmarkdown

License GPL-2

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LazyData true

RoxygenNote 7.1.0

VignetteBuilder knitr

NeedsCompilation no

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AMA *AMA indices*

Description

This function calculates the AMA indices: AMAE, AMAV, AMAV and AMAK.

Usage

```
AMA(data_Bstat, CM, pp_names, steps = 100)
```

Arguments

`data_Bstat`	a data frame of dimensions t x 6, here t is the number of temporary steps and each column corresponds to a statistical measure: mean, variance, skewness, kurtosis and excess kurtosis.
`CM`	A list of arrays, each array corresponds to the conditional moments calculated with the mean, variance, skewness, kurtosis. Each array has dimensions of steps, t, p.
`pp_names`	vector that contains the names of the parameters (pp)
`steps`	number of divisions of the parametric range

Value

A list of four matrices, which corresponds to AMAE, AMAV, AMAR and AMAK indices. Each matrix has dimensions of t x pp.

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References

Dell'Oca, A., Riva, M., & Guadagnini, A. (2017). Moment-based metrics for global sensitivity analysis of hydrological systems. Hydrology and Earth System Sciences, 21(12), 6219–6234. https://doi.org/10.5194/hess-21-6219-2017

Examples

```
data("data_Bstat", "CM", "pp_names")
AMA_indices <- AMA(data_Bstat, CM, pp_names, steps= 15)
```

Bstat *Basic statistical measures of a mathematical model results*

Description

This function calculates the mean, variance, skewness, kurtosis and excess kurtosis of a model output, this output can be given for different temporal periods (days, months or years).

Usage

```
Bstat(out_set)
```

Arguments

`out_set`	matrix of dimensions n x t, where n equals the number of runs and t is equal to the number of temporary steps.

Value

a data frame of dimensions t x 6, here t is the number of temporary steps and each column corresponds to a statistical measure: mean, variance, skewness, kurtosis and excess kurtosis.

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Examples

```
data("out_set")
data_Bstat <- Bstat(out_set)
```

CM *@title First four conditional moments of example data*

Description

@description Data generated by Cond_Moments example

Usage

```
CM
```

Format

A `list`

CM A list of arrays, each array has dimensions of steps, t, pp

Author(s)

Camila Garcia-Echeverri

Cond_Moments *Conditional statistical moments of a model output*

Description

This function evaluates the first four statistical moments after grouping the model output by different parametric ranges.

Usage

```
Cond_Moments(parameters_set, out_set, pp_names, steps = 100)
```

Arguments

`parameters_set`	matrix of dimensions n x pp, where n is the number of runs and pp is the number of parameters.
`out_set`	matrix of dimensions n x t, where n is the number of runs and t is the number of temporary steps.
`pp_names`	vector that contains the names of the parameters.
`steps`	number of divisions of the parametric range.

Value

A list of arrays, each array has dimensions of steps, t, pp.

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Examples

```
data("parameters_set", "out_set", "pp_names")

CM <- Cond_Moments(parameters_set, out_set, pp_names, steps=15)
```

`data_Bstat` *@title First four conditional moments of example data*

Description

@description Data generated with the example of the function Cond_Moments

Usage

```
data_Bstat
```

Format

A `data.frame`

data_Bstat a data frame of dimensions t x 6

Author(s)

Camila Garcia-Echeverri

Source

Function Bstat

GSAtool *Global Sensitivity Analysis tool*

Description

This function performs the global sensitivity analysis starting from the gross results of the model.

Usage

```
GSAtool(
  parameters_set,
  out_set,
  pp_names,
  steps = 100,
  save = FALSE,
  dir = NULL
)
```

Arguments

parameters_set	matrix of dimensions n x pp, where n is the number of runs and pp is the number of parameters.
out_set	matrix of dimensions n x t, where n is the number of runs and t is the number of temporary steps.
pp_names	a strings vector with the names of the parameters of the model
steps	number of divisions of the parametric range.
save	T to save the results in .csv files, by default save=F.
dir	a directory to save the results

Value

a list containing two outputs: SOBOL and AMA indices.

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References

Dell'Oca, A., Riva, M., & Guadagnini, A. (2017). Moment-based metrics for global sensitivity analysis of hydrological systems. Hydrology and Earth System Sciences, 21(12), 6219–6234. https://doi.org/10.5194/hess-21-6219-2017

Sobol, I. M. (2001). Global sensitivity indices for nonlinear mathematical models and their Monte Carlo estimates. Mathematics and Computers in Simulation, 55(1–3), 271–280. https://doi.org/10.1016/S0378-4754(00)00270-6

Examples

```
data("parameters_set", "out_set", "pp_names")


GSA_results <- GSAtool(parameters_set, out_set, pp_names, steps = 15, save=FALSE)
```

`out_set` *@title Results of a sample model*

Description

@description Output generated with an example mathematical model.

Usage

```
out_set
```

Format

A `matrix`

out_set a matrix of dimensions 500 x 365 (pp x t), runs of the model x temporary steps (365 days)

References

Arenas-Bautista, M. C. (2020). Integration of Hydrological and Economical Aspects for Water Management in Tropical Regions. Case Study: Middle Magdalena Valley, Colombia. National University of Colombia.

parameters_set *@title Set of parameters randomly generated*

Description

@description It contains 10 parameters

Usage

```
parameters_set
```

Format

A `matrix`

parameters_set a matrix of dimensions 500 x 10 (n x pp),runs of the model x number of parameters

References

Arenas-Bautista, M. C. (2020). Integration of Hydrological and Economical Aspects for Water Management in Tropical Regions. Case Study: Middle Magdalena Valley, Colombia. National University of Colombia.

pp_names *@title Example - parameters names*

Description

@description 10 parameters names.

Usage

```
pp_names
```

Format

A `value`

pp_names a vector of characters

Author(s)

CGE

References

Arenas-Bautista, M. C. (2020). Integration of Hydrological and Economical Aspects for Water Management in Tropical Regions. Case Study: Middle Magdalena Valley, Colombia. National University of Colombia.

save_results *Save GSA results*

Description

This function helps to save the results in .csv format

Usage

```
save_results(
  SOBOL = NULL,
  SOBOL_total = NULL,
  amae = NULL,
  amav = NULL,
  amar = NULL,
  amak = NULL,
  dir
)
```

Arguments

SOBOL	SOBOL index
SOBOL_total	SOBOL_total
amae	AMAE index
amav	AMAV index
amar	AMAR index
amak	AMAK index
dir	a directory to save the results

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SOBOL *SOBOL indices*

Description

This function calculates the first order and total SOBOL indices.

Usage

```
SOBOL(data_var, CM_mean, CM_var, pp_names)
```

Arguments

data_var	a vector containing the variance of the model output for each modelling time step.
CM_mean	An array containing the conditional mean of each parameter of the model. This array has dimensions of steps x t x pp, where steps is the number of divisions of the parametric range, t is the number of temporary steps and pp the number of parameters of the model.
CM_var	An array containing the conditional variance of each parameter of the model. This array has dimensions of steps x t x pp, where steps is the number of divisions of the parametric range, t is the number of temporary steps and pp the number of parameters of the model.
pp_names	a strings vector with the names of the parameters of the model.

Value

a list containing two matrices. The first contains the first order sobol, the second sobol_total.

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References

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Examples

```
data("data_Bstat", "CM", "pp_names")
SOBOL_indices <- SOBOL(data_Bstat[,3], CM$CM_mean, CM$CM_var , pp_names)
```

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