

# Package ‘GenSA’

February 15, 2023

**Type** Package

**Title** R Functions for Generalized Simulated Annealing

**Version** 1.1.8

**Date** 2023-02-09

**Author** Sylvain Gubian, Yang Xiang, Brian Suomela, Julia Hoeng, PMP SA.

**Maintainer** Sylvain Gubian <DL.RSupport@pmi.com>

**Depends** R (>= 2.12.0)

**Description** Performs search for global minimum of a very complex non-linear objective function with a very large number of optima.

**License** GPL-2

**LazyLoad** yes

**NeedsCompilation** yes

**Repository** CRAN

**RoxygenNote** 7.2.3

**Date/Publication** 2023-02-15 10:40:05 UTC

## R topics documented:

GenSA . . . . .	1
<b>Index</b>	<b>5</b>

---

GenSA	<i>Generalized Simulated Annealing Function</i>
-------	-------------------------------------------------

---

### Description

This function searches for global minimum of a very complex non-linear objective function with a very large number of optima.

**Usage**

```
GenSA(par = NULL, fn, lower, upper, control = list(), ...)
```

**Arguments**

<code>par</code>	Vector. Initial values for the components to be optimized. Default is NULL, in which case, default values will be generated automatically.
<code>fn</code>	A function to be minimized, with first argument the vector of parameters over which minimization is to take place. It should return a scalar result.
<code>lower</code>	Vector with length of <code>par</code> . Lower bounds for components.
<code>upper</code>	Vector with length of <code>par</code> . Upper bounds for components.
<code>control</code>	The argument is a list that can be used to control the behavior of the algorithm <ul style="list-style-type: none"> <li><code>maxit</code> Integer. Maximum number of iterations of the algorithm.</li> <li><code>threshold.stop</code> Numeric. The program will stop when the expected objective unction value <code>threshold.stop</code> is reached. Default value is NULL</li> <li><code>nb.stop.improvement</code> Integer. The program will stop when there is no any improvement in <code>nb.stop.improvement</code> steps.</li> <li><code>smooth</code> Logical.TRUE when the objective function is smooth, or differentiable almost everywhere in the region of <code>par</code>, FALSE otherwise. Default value is TRUE.</li> <li><code>max.call</code> Integer. Maximum number of call of the objective function. Default is set to <math>1e7</math>.</li> <li><code>max.time</code> Numeric. Maximum running time in seconds.</li> <li><code>temperature</code> Numeric. Initial value for temperature.</li> <li><code>visiting.param</code> Numeric. Parameter for visiting distribution.</li> <li><code>acceptance.param</code> Numeric. Parameter for acceptance distribution.</li> <li><code>verbose</code> Logical. TRUE means that messages from the algorithm are shown. Default is FALSE.</li> <li><code>simple.function</code> Logical. FALSE means that the objective function has only a few local minima. Default is FALSE which means that the objective function is complicated with many local minima.</li> <li><code>trace.mat</code> Logical. Default is TRUE which means that the trace matrix will be available in the returned value of GenSA call.</li> <li><code>seed</code> Integer. Negative integer value that can be set to initialize the internal random generator.</li> </ul>
<code>...</code>	allows the user to pass additional arguments to the function <code>fn</code> .

**Details**

The default values of the control components are set for a complex optimization problem. For usual optimization problem with medium complexity, GenSA can find a reasonable solution quickly so the user is recommended to let GenSA stop earlier by setting `threshold.stop`. If `threshold.stop` is the expected function value, or by setting `max.time`. If the user just want to run GenSA for `max.time` seconds, or by setting `max.call`. If the user just want to run GenSA within `max.call` function calls. Please refer to the examples below. For very complex optimization problems, the user is recommended to increase `maxit` and `temp`.

**Value**

The returned value is a list with the following fields:

**value** Numeric. The value of `fn` corresponding to `par`.

**par** Vector. The best set of parameters found.

**trace.mat** A matrix which contains the history of the algorithm. (By columns: Step number, temperature, current objective function value, current minimal objective function value).

**counts** Integer. Total number of calls of the objective function.

**Author(s)**

Yang Xiang, Sylvain Gubian, Brian Suomela, Julia Hoeng, PMP SA. . (Y.Xiang and S.Gubian are equal contributors)

**References**

Xiang Y, Gubian S, Martin F (2017). "Generalized Simulated Annealing." IntechOpen, Computational Optimization in Engineering, Chapter 2.

Xiang Y, Gubian S, Suomela B, Hoeng (2013). "Generalized Simulated Annealing for Efficient Global Optimization: the GenSA Package for R". The R Journal Volume 5/1, June 2013.

Xiang Y, Sun DY, Gong XG (2000). "Generalized Simulated Annealing Studies on Structures and Properties of  $N_n$  ( $n=2-55$ ) Clusters." Journal of Physical Chemistry A, 104, 2746–2751.

Xiang Y, Gong XG (2000a). "Efficiency of Generalized Simulated Annealing." PHYSICAL REVIEW E, 62, 4473.

Xiang Y, Sun DY, Fan W, Gong XG (1997). "Generalized Simulated Annealing Algorithm and Its Application to the Thomson Model." Physics Letters A, 233, 216–220.

Tsallis C, Stariolo DA (1996). "Generalized Simulated Annealing." Physica A, 233, 395–406.

Tsallis C (1988). "Possible generalization of Boltzmann-Gibbs statistics." Journal of Statistical Physics, 52, 479–487.

**Examples**

```
library(GenSA)
# Try Rastrgin function (The objective function value for global minimum
# is 0 with all components of par are 0.)
Rastrgin <- function(x) {
  sum(x^2 - 10 * cos(2 * pi * x)) + 10 * length(x)
}
# Perform the search on a 30 dimensions rastrgin function. Rastrgin
# function with dimension 30 is known as the most
# difficult optimization problem according to "Yao X, Liu Y, Lin G (1999).
# \Evolutionary Programming Made Faster."
# IEEE Transactions on Evolutionary Computation, 3(2), 82-102.
# GenSA will stop after finding the targeted function value 0 with
# absolute tolerance 1e-13
set.seed(1234) # The user can use any seed.
dimension <- 30
```

```
global.min <- 0
tol <- 1e-13
lower <- rep(-5.12, dimension)
upper <- rep(5.12, dimension)
out <- GenSA(lower = lower, upper = upper, fn = Rastrigin,
             control=list(threshold.stop=global.min+tol,verbose=TRUE))
out[c("value", "par", "counts")]

# GenSA will stop after running for about 2 seconds
# Note: The time for solving this problem by GenSA may vary
# depending on the computer used.
set.seed(1234) # The user can use any seed.
dimension <- 30
global.min <- 0
tol <- 1e-13
lower <- rep(-5.12, dimension)
upper <- rep(5.12, dimension)
out <- GenSA(lower = lower, upper = upper, fn = Rastrigin,
             control=list(max.time=2))
out[c("value", "par", "counts")]
```

# Index

GenSA, [1](#)