# Package 'LA'

May 11, 2022

**Type** Package

**Title** Lioness Algorithm (LA)

**Version** 2.1

**Date** 2022-05-06

**Description**
Contains Lioness Algorithm (LA) for finding optimal designs over continuous design space, optimal Latin hypercube designs, and optimal order-of-addition designs. LA is a brand new nature-inspired meta-heuristic optimization algorithm. Detailed methodologies of LA and its implementation on numerical simulations can be found at Hongzhi Wang, Qian Xiao and Abhyuday Mandal (2021) <arXiv:2010.09154>.

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**Encoding** UTF-8

**Suggests** testthat (>= 3.0.0), knitr, rmarkdown, devtools

**Imports** Rcpp

**LinkingTo** Rcpp, RcppArmadillo

**RoxygenNote** 7.1.2

**NeedsCompilation** yes

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**Repository** CRAN

**Date/Publication** 2022-05-11 15:30:07 UTC

## R topics documented:

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LA_LHDC                          *Lioness Algorithm for Latin hypercube design*

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**Description**

LA_LHDC returns a n by k Latin hypercube design matrix generated by lioness algorithm (LA)

**Usage**

```
LA_LHDC(n, k, m = 100L, N = 5000L, OC = "phi_p", p = 15L, q = 1L)

permuC(x)

seqC(a, b)

rLHDC(n, k)

dijC(X, i, j, q = 1L)

phi_pC(X, p = 15L, q = 1L)

MaxProCriterionC(X)

corC(x, y)

MaxAbsCorC(X)

AvgAbsCorC(X)

exchangeC(X, j, type = "col")
```

**Arguments**

| | |
|---|---|
| n | A positive integer, which stands for the number of rows (or run size). |
| k | A positive integer, which stands for the number of columns (or factor size). |
| m | A positive integer, which stands for the number of starting lionesses agents. The default is set to be 100. |
| N | A positive integer, which stands for the number of iterations. The default is set to be 5000. A large value of N will result a high CPU time. |
| OC | An optimality criterion. The default setting is "phi_p", and it could be one of the following: "phi_p", "AvgAbsCor", "MaxAbsCor", "MaxProCriterion". |
| p | A positive integer, which is the parameter in the phi_p formula, and p is prefered to be large. The default is set to be 15. |
| q | The default is set to be 1, and it could be either 1 or 2. If q is 1, dij is the Manhattan (rectangular) distance. If q is 2, dij is the Euclidean distance. |

| | |
|---|---|
| x | is a vector. |
| a | is the starting value of the sequence. |
| b | is the ending value of the sequence. |
| X | A matrix object. In general, X stands for a design matrix. |
| i | A positive integer, which stands for the ith row of X. |
| j | A positive integer, which stands for the jth column (or row) of X, and it should be within [1,ncol(X)] (or [1,nrow(X)]). |
| y | is a vector. |
| type | An exchange type. If type is "col" (the default setting), two random elements will be exchanged within column j. If type is "row", two random elements will be exchanged within row j. |

## Value

If all inputs are logical, then the output will be a n by k LHD.

## Examples

```
#generate a 6 by 3 maximin distance LHD with the default setting
try=LA_LHDC(n=6,k=3)
try

#Another example
#generate a 9 by 4 nearly orthogonal LHD
try2=LA_LHDC(n=9,k=4,OC="AvgAbsCor")
try2
```

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LA_OofAC                     *Lioness Algorithm for order-of-addition design*

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## Description

LA_OofAC returns a n by k D-optimal order-of-addition design matrix generated by lioness algorithm (LA)

## Usage

```
LA_OofAC(n, k, m = 100L, N = 5000L)

factorialC(x)

modC(a, b)

rOofAC(n, k)
```

```
PWOC(X)

TC(X)

MOMC(X)
```

## Arguments

| | |
|---|---|
| n | A positive integer, which stands for the number of rows (or run size). Note that the maximum of n cannot be greater than k factorial. |
| k | A positive integer, which stands for the number of columns (or factor size). |
| m | A positive integer, which stands for the number of starting lionesses agents. The default is set to be 100. |
| N | A positive integer, which stands for the number of iterations. The default is set to be 5000. A large value of N will result a high CPU time. |
| x | is a positive integer. |
| a | is a positive integer. |
| b | is a positive integer. |
| X | A matrix object. In general, X stands for the design matrix. |

## Value

If all inputs are logical, then the output will be a n by k order-of-addition design.

## Examples

```
#generate a D-optimal full OofA with 4 factors.
try=LA_OofAC(n=24,k=4,m=10,N=50)
try

#Another example
#generate a D-optimal 11-run OofA with 4 factors.
try2=LA_OofAC(n=11,k=4,m=10,N=50)
try2
```

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LA_OptC                          *Lioness Algorithm for experimental designs with continuous input*

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## Description

LA_OptC returns optimal designs with continuous input

## Usage

```
LA_OptC(n, lb, ub, m = 100L, N = 5000L, OC = "D", alpha = 0.1)

D(X)

A(X)

GscoreC(X, x)

rSign(m = 2L)

G(Y)
```

## Arguments

| | |
|---|---|
| n | A positive integer, which stands for the number of rows (or run size) for a design. |
| lb | A vector contains the lower bounds of all the input variables. For example, if there are 3 input variables whose lower bounds are 0, 5, and 15, lb should be lb=c(0,5,15). |
| ub | A vector contains the upper bounds of all the input variables. For example, if there are 3 input variables whose upper bounds are 10, 15, and 25, ub should be lb=c(10,15,25). |
| m | A positive integer. |
| N | A positive integer, which stands for the number of iterations. The default is set to be 5000. A large value of N will result a high CPU time. |
| OC | An optimality criterion. The default setting is "D-optimality". It could be one of the following: "D", "A", and "G", which stands for "D-optimality", "A-optimality", and "G-optimality", respectively. |
| alpha | A tuning parameter in algorithm for controlling how big the change would be when updating elements in the step of avoiding local optimum. The default is set to be 0.1, which is the recommended value. |
| X | A matrix object. In general, X stands for the design matrix. |
| x | is a vector. |
| Y | A matrix object. In general, Y stands for the design matrix. |

## Value

If all inputs are logical, then the output will be either a n by length(lb) optimal design. Here, the length(lb) is assumed to be at least 2.

## Examples

```
#Assume in a simple linear regression model, we want to find a D-optimal
#20-run design, where the input variable takes values between 0 and 24.
#In theory, we know the optimal design is the following:
#matrix(c(rep(1,20),rep(0,10),rep(24,10)),ncol=2,nrow=20,byrow=FALSE)
```

```
#Use LA with default setting to find the optimal design for above problem.
try=LA_OptC(n=20,lb=c(1,0),ub=c(1,24))
round(try,8)
```

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