

# Package ‘MMAD’

March 12, 2026

**Title** An R Package of Minorization-Maximization Algorithm via the Assembly--Decomposition Technology

**Version** 2.0.1

**Description** The minorization-maximization (MM) algorithm is a powerful tool for maximizing non-concave target function. However, for most existing MM algorithms, the surrogate function in the minorization step is constructed in a case-specific manner and requires manual programming. To address this limitation, we develop the R package MMAD, which systematically integrates the assembly--decomposition technology in the MM framework. This new package provides a comprehensive computational toolkit for one-stop inference of complex target functions, including function construction, evaluation, minorization and optimization via MM algorithm. By representing the target function through a hierarchical composition of assembly functions, we design a hierarchical algorithmic structure that supports both bottom-up operations (construction, evaluation) and top-down operation (minorization).

**License** GPL-3

**Encoding** UTF-8

**RoxygenNote** 7.3.2

**Imports** utils

**Depends** R (>= 2.10)

**Suggests** testthat (>= 3.0.0)

**Config/testthat/edition** 3

**NeedsCompilation** no

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**Repository** CRAN

**Date/Publication** 2026-03-12 15:10:09 UTC

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Function\_construction *Function Construction*

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### Description

This function allows the user to create the target function in an interactive manner. Here, the target function is expressed as

$$f(\boldsymbol{\theta}) = f_J(\theta_1, \dots, \theta_p, f_1, \dots, f_{J-1}),$$

where

- $f_1$  is a function of  $\theta_1, \dots, \theta_p$ ;
- $f_j$  is a function of  $\theta_1, \dots, \theta_p, f_1, \dots, f_{j-1}$ , for  $j = 2, \dots, J$ ;
- $f_1, \dots, f_J$  belongs to the bank of assembly functions.

Here, user can input the function by

1. inputting the dimensionality  $p$ ;
2. for  $j = 1, \dots, J$ ;
  - (a) selecting which assembly function  $f_j$  belongs to;
  - (b) inputting the indexes of coefficients or existing functions included as arguments of  $f_j$ ;
  - (c) inputting the coefficients.

### Usage

Function\_construction()

### Value

An R list depicting the target function.

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Function\_evaluation    *Function Evaluation*

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**Description**

This function allows the user to compute the value, gradients and the Hessian matrix of the target function  $f(\theta)$  at a given point  $\theta^*$ .

**Usage**

```
Function_evaluation(Function_obj, input)
```

**Arguments**

Function\_obj    An R list depicting the target function.  
input            The value  $\theta^*$  at which the target function is evaluated.

**Value**

An R list recording the value, gradients and the Hessian matrix of the target function  $f(\theta)$  at a given point  $\theta^*$ .

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Function\_minimization    *Function Minimization*

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**Description**

This function allows the user to minimize the target function  $f(\theta)$  at a given point  $\theta^*$ .

**Usage**

```
Function_minimization(Function_obj, input)
```

**Arguments**

Function\_obj    An R list depicting the target function.  
input            The value  $\theta^*$  at which the target function is minimized.

**Value**

An R list recording the surrogate function  $S(\theta|\theta^*) = S_C + \sum_{i=1}^p S_i(\theta_i|\theta^*)$  where

- the first  $p$  objects (named Surrogate\_1, Surrogate\_2, ..., Surrogate\_p) record  $S_1(\theta_1|\theta^*), \dots, S_p(\theta_p|\theta^*)$ ;
- the final object (named Constant) records the constant  $S_C$ .

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MMAD                      *Minorization-Maximization Algorithm via the Assembly-  
Decomposition Technology*

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**Description**

This function allows the user to maximize the target function  $f(\boldsymbol{\theta})$  using MM algorithm with AD technology.

**Usage**

```
MMAD(Function_obj, init, tol = 1e-04)
```

**Arguments**

Function_obj	An R list depicting the target function.
init	The initial value $\boldsymbol{\theta}^{(0)}$ for iterative optimization.
tol	The tolerance for convergence detection (default: $1 \times 10^{-4}$ ).

**Value**

The maximizer

$$\hat{\boldsymbol{\theta}} = \arg \max_{\boldsymbol{\theta} \in \Theta} f(\boldsymbol{\theta}).$$

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