Package ‘MMAD’

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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 nonconcave 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).

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Imports utils

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`Function_construction` *Function Construction*

Description

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

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

where

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

Here, user can input the function by

1. inputting the dimensionality p;
2. for $j = 1, \ldots, J$;
   (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.

`Function_evaluation` *Function Evaluation*

Description

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

Usage

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

Arguments

`Function_obj`	An R list depicting the target function.
`input`	The value $\boldsymbol{\theta}^*$ at which the target function is evaluated.

Value

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

`Function_minorization` *Function Minorization*

Description

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

Usage

```
Function_minorization(Function_obj, input)
```

Arguments

`Function_obj`	An R list depicting the target function.
`input`	The value $\boldsymbol{\theta}^*$ at which the target function is minorized.

Value

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

- the first p objects (named Surrogate_1, Surrogate_2, ..., Surrogate_p) record $S_1(\theta_1|\boldsymbol{\theta}^*), \ldots, S_p(\theta_p|\boldsymbol{\theta}^*)$;
- the final object (named Constant) records the constant S_C.

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

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: 1×10^{-4}).

Value

The maximizer

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

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