`MSSearch` *MSSearch*

Description

The `MSSearch` function can be used to obtain an optimal multi-stratum experimental design considering one or more optimization criteria, up to a maximum of six criteria simultaneously.
This function implements the procedure MS-Opt proposed by Sambo, Borrotti, Mylona e Gilmour (2017) as an extension of the Coordinate-Exchange Algorithm for constructing exact optimal experimental designs. This innovative procedure, instead of minimizing a single objective function as in the CE algorithm, seeks to minimize the following scalarization of the objective functions for all criteria under consideration:

$$f_W = \sum_{c \in C} \alpha_c f_c(d;\eta) = \overline{\alpha} \cdot \overline{f},$$

with

$$\sum_{c} (\alpha_c) = 1$$

where c is the set of criteria to be minimized, f_c is the objective function for the c criterion and $\overline{\alpha}$ is the vector that controls the relative weights of the objective functions.

Usage

```
MSSearch(msopt, alpha, ...)

MSSearch(msopt, alpha, "Start", sol, "Restarts", r, "Normalize",
c(CritTR, CritSC )))
```

Arguments

`msopt`	A list as returned by the `MSOpt` function.
`alpha`	A vector of weights, whose elements must sum to one. `length(alpha)` must be equal to the number of criteria considered, that is, it must be equal to the length of the `criteria` element of the `msopt` argument.
`...`	optional arguments (see below).

Details

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Additional arguments can be specified as follows:

- `'Start',sol`: A string and a matrix, used in pair. They provide a starting solution (`sol`) or initial design to the algorithm. By default the initial solution is randomly generated following the *SampleDesign* procedure described in Sambo, Borrotti, Mylona and Gilmour (2017).
- `'Restarts',r` : A string and an integer, used in pair. When `r=1`, the default value, the procedure implemented in `MSSearch` results in a local search algorithm that optimizes the objective function f_W starting from one initial design in the design space. These parameters allows to restart the algorithm `r` times. If no initial design is passed a

different starting solution is generated for each iteration, letting the probability to find a global minimum be higher. `Mssearch` returns the solution that minimizes f_W across all the `r` iterations.

- `'Normalize',c(CritTR,CritSC)`: A string and a vector, used in pair. By specifying the `CritTR` and `CritSC` vectors, the user can establish the normalization factors to be applied to each objective function before evaluating f_W. `CritTR` and `CritSC` are vectors of length equal to the number of criteria, whose default elements are 0 and 1 respectively.

Value

`MSSearch` returns a list, whose elements are:

- `optsol`: A design matrix. The best solution found.
- `optscore`: A vector containing the criteria scores for `optsol`.
- `feval`: An integer representing the number of score function evaluations (number of f_W evaluations over all iterations).
- `trend`: A vector of length `r`. The i-th element is the value that minimizes f_W for the i-th iteration.

References

M. Borrotti and F. Sambo and K. Mylona and S. Gilmour. A multi-objective coordinate-exchange two-phase local search algorithm for multi-stratum experiments. Statistics & Computing, 2017.