TEAM: UN-KIT-SWITCHING BATTERY

Cooperation of Universidad Nacional de Colombia (UN), Karlsruhe Institute of Technology (KIT) and SWITCHING BATTERY company

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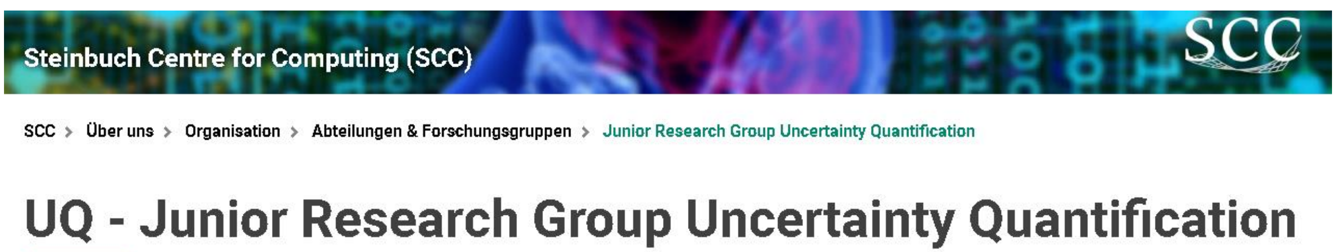
https://ingenieria.bogota.unal.edu.co/es/dependencias/departamentos/departamento-de-ingenieria-electrica-y-electronica.html

https://www.scc.kit.edu/ueberuns/uq.php



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ENSEMBLED ALGORITHM MVMO-RCEDUMDA-HyDE

- **INTRODUCTION**
- **APPROACH**
  - ENSEMBLED IN OPTIMIZATION TECHNIQUES
  - A. MVMO (Mean-Variance Mapping Optimization
  - B. RCEDUMDA (Ring Cellular Encode-Decode UMDA)
  - C. HyDE (Hybrid-adaptive differential evolution)
- **PERFORMANCE**

IEEE PES Power & Energy Society®

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- **APPROACH FOR THE 2023 SMART GRID COMPETITION**

- INITIALIZATION →

    A. MVMO (Mean-Variance Mapping Optimization

- EXPLORATION AND EXPLOITATION →

    B. RCEDUMDA (Ring Cellular Encode-Decode UMDA)

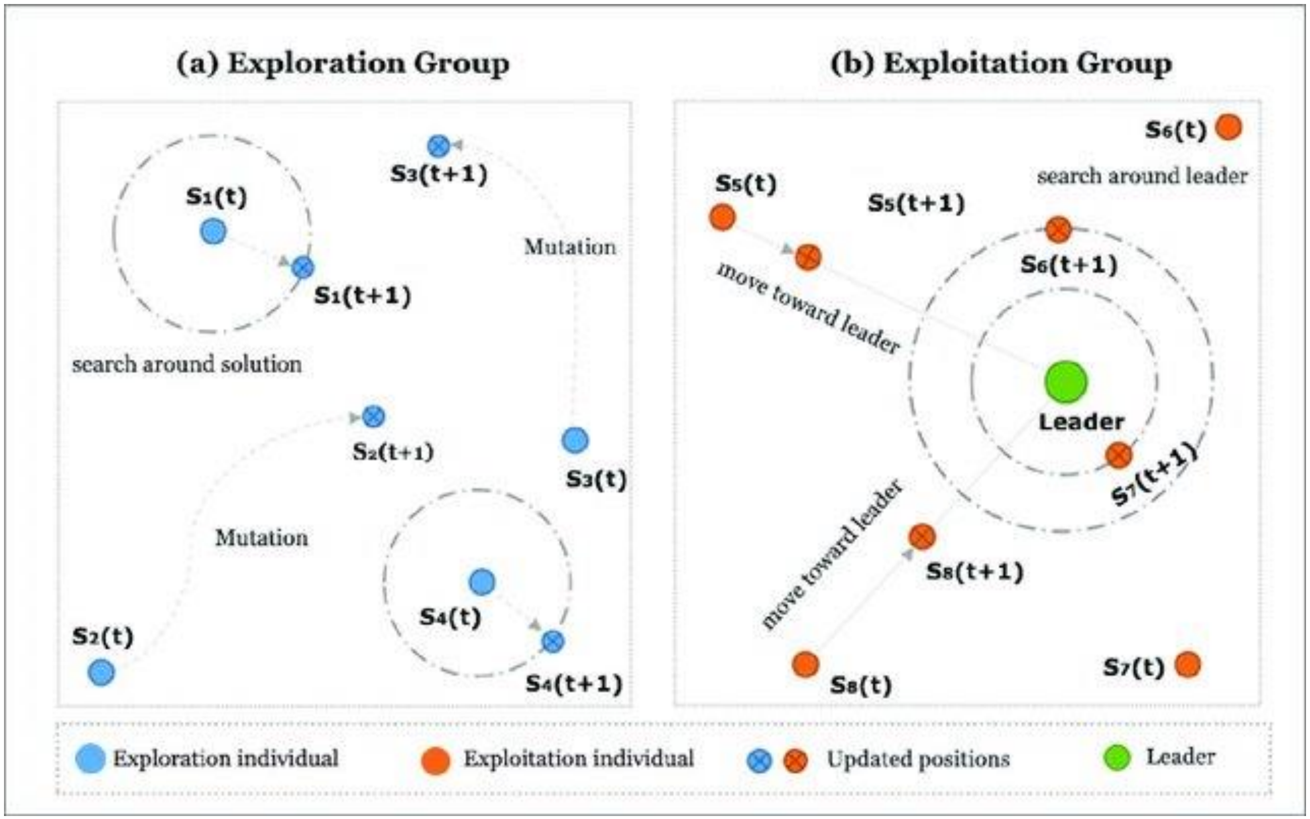
- EXPLOITATION →

    C. HyDE (Hybrid-adaptive differential evolution)

- TUNING PROCESS

○ **APPROACH FOR THE 2023 SMART GRID COMPETITION**

❖ EXPLORATION AND EXPLOITATION →

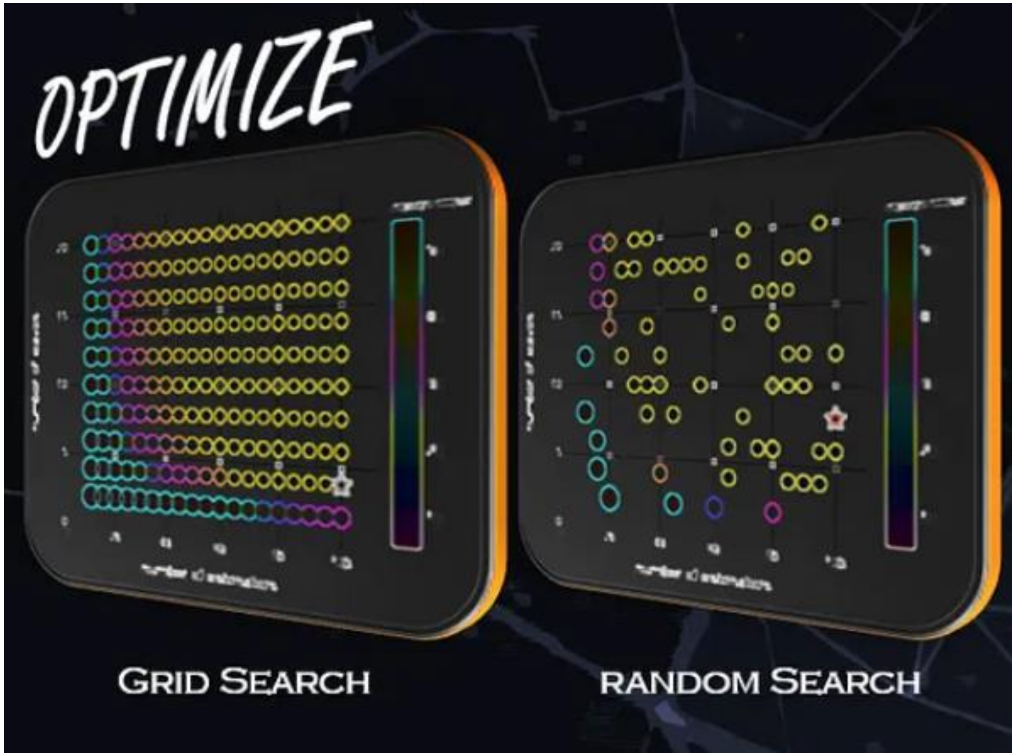


RCEDUMDA and HyDE

RULES

○ APPROACH FOR THE 2023 SMART GRID COMPETITION

❖ TUNING PROCESS



○ APPROACH FOR THE 2023 SMART GRID COMPETITION

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Gradient
Free
Optimizers

Efficient Search with an Ensemble of Heuristics

A. MVMO (Mean-Variance Mapping Optimization)

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Technische Universiteit Delft

Application of Mean Variance Mapping Optimization (MVMO) to Solve OPF Problems

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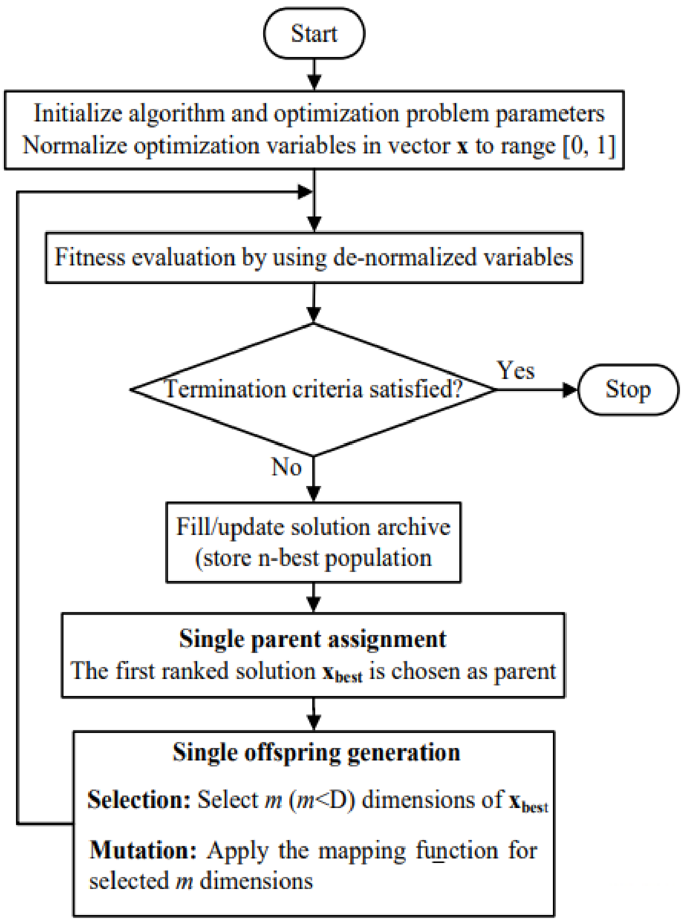
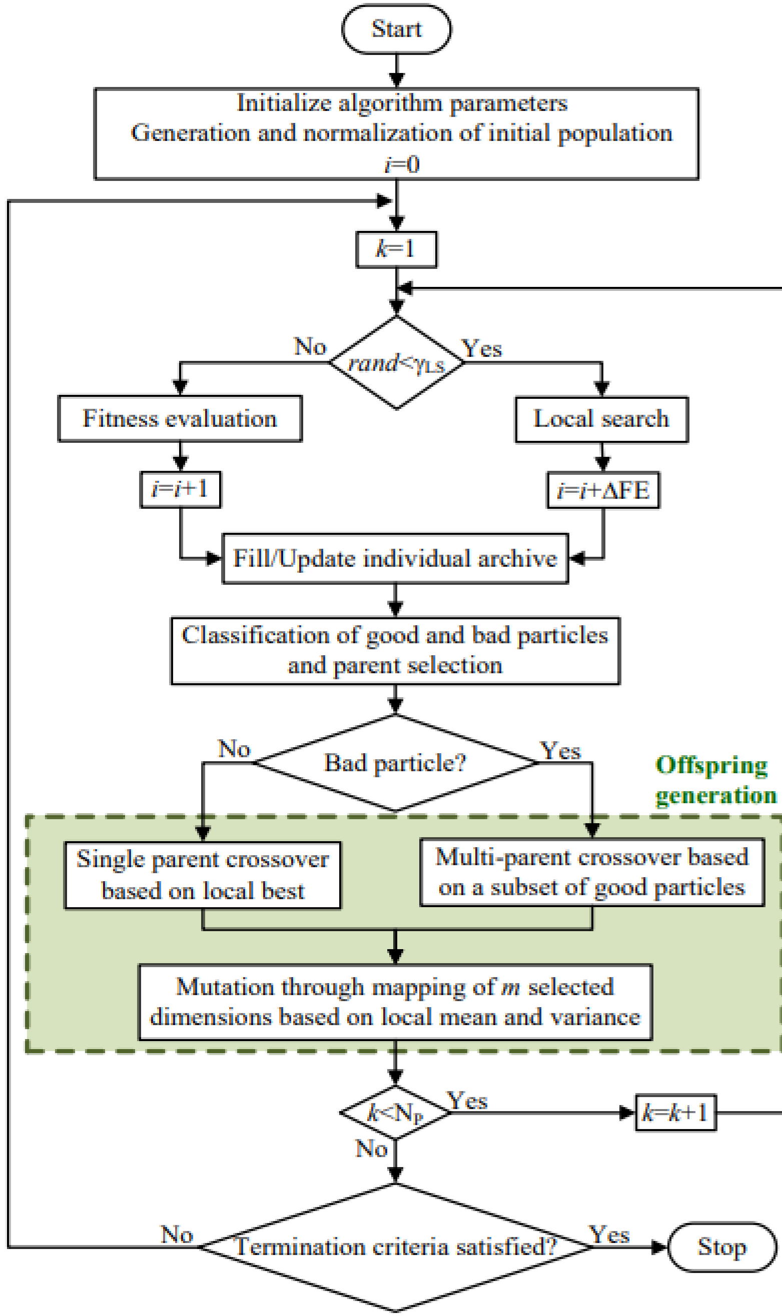
A. MVMO (Mean-Variance Mapping Optimization)

Rationale behind MVMO

- Introduced by I. Erlich (University Duisburg-Essen, Germany) in 2010
- Internal search range of all variables restricted to [0, 1].
- **Solution archive:** knowledge base for guiding the searching direction.
- **Mapping function:** Applied for mutating the offspring on the basis of the mean and variance of the n-best population attained so far.

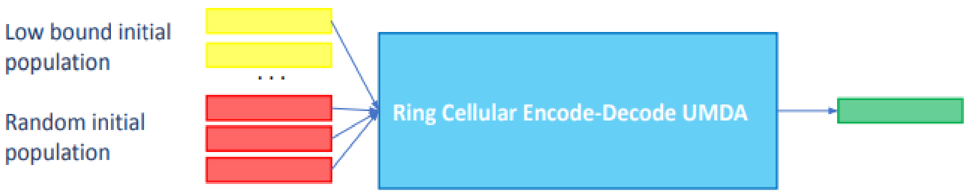


The hybrid variant: MVMO



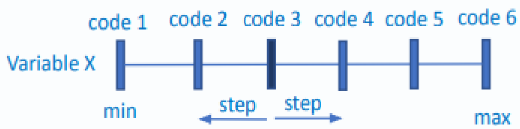
B. RCEDUMDA (Ring Cellular Encode-Decode UMDA)

RCEDUMDA: Ring Cellular Encode-Decode UMDA



Reduces the search space converting the continuous variables into categorical variables (encoding) and reconverting the categorical variables into continuous variables (decoding).

Use a discrete step into a range of the number of codes parameter. Example with 6 codes and step=1:



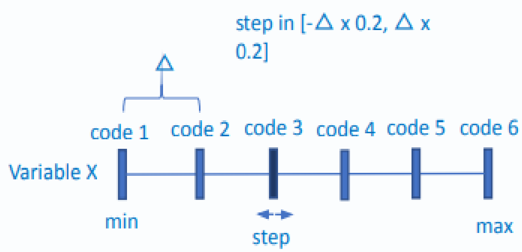
Uses a **cellular ring** structure **for partitioning the population** into many small sub-populations or cells.

Reduces the search space converting the continuous variables into categorical variables (encoding) and reconverting the categorical variables into continuous variables (decoding).

Generates new encoded individuals from the **univariate marginal distribution** (including scales probabilities) of the best encoded individuals of the sub-populations.

Uses **elitism** to maintain the best individuals in the next generation

The range of the step is a fraction of the range between values associated with the codes. Example with 6 codes and ratio = 0.2:



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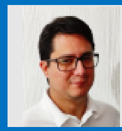



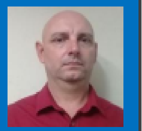

B. RCEDUMDA (Ring Cellular Encode-Decode UMDA)

RCEDUMDA: Ring Cellular Encode-Decode UMDA

Ring Cellular Encode-Decode UMDA (RCEDUMDA)

```
function RCEDUMDA(Pop, c, m, maxIt, l, s, r, α, k, minB, maxB)
  ▷ Input:
    Pop - initial population
    c - number of cells,                 m - size of the cells,
    maxIt - maximum iteration,           l - number of elitist individuals,
    s - number of selected individual,   r - neighborhood ratio,
    α - additional occurrence,           k - number of codes,
    minB - vector of min bounds,         maxB - vector of max bounds   ◁
  ▷ Output:
    bestSol - best solution   ◁
  t ← 1
  while t ≤ maxIt do
    Select globally l elitist individuals
    for all cell ∈ Pop do
      M ← the m best individuals in neighborhood(cell, r)
      eM ← encode(M, k, minB, maxB)
      p ← the estimated distribution ∏_{i=1}^{l} p(x_i) from eM
      p ← scale(p, α)
      eC ← c new individuals generating according to p
      C ← decode(eC, k, minB, maxB)
      Insert C in the same cell of an auxiliary population auxPop
    Replace the Pop with auxPop
    Include the elitist individuals, replacing the individuals in their positions
    t ← t + 1
  bestSol ← the best individual in Pop
  return bestSol
```

General considerations

- Pop is structured as a ring composed of adjacent cells. Each cell contains a set of individuals.
- Elitist individuals are not evaluated in later generations. This fact saves evaluations that are used in extra generations.
- An initial population that includes the 20% of solutions initialized with the variable's lower bounds is a diverse but promising sample of the search space.

Further related bibliography

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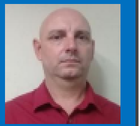

C. HyDE (Hybrid-adaptive differential evolution)

```
HyDE(deParameters,otherParameters,low_habitat_limit,up_habitat
_limit,initialSolution)

% Author: Fernando Lezama, GECAD/ISEP 2019 (Contact
ing.flezama@gmail.com)

% Description:  Minimization of a user-supplied function with
respect to x(1:I_D), using Hybrid-adaptive differential
evolution with decay function (HyDE-DF).

% For this algorithm we download DE source code from Rainer
Storn, Ken Price, Arnold Neumaier, Jim Van Zandt.

% Due to the vectorized expressions it executes  fairly fast
in MATLAB's interpreter environment.
```

C. HyDE (Hybrid-adaptive differential evolution)

Differential evolution (DE) algorithm is a simple, fast and efficient population-based direct search algorithm to solve global optimization problems. Due to the advantages of the simple structure, easy use, robustness, and fast convergence, the DE algorithm has been widely used in many fields, and achieved good applied results. The DE algorithms use the basic framework of genetic algorithm to design a unique differential mutation operator. Their basic operation includes the mutation operation, crossover operation and selection operation. The flow chart of DE algorithm is shown in Figure 1.

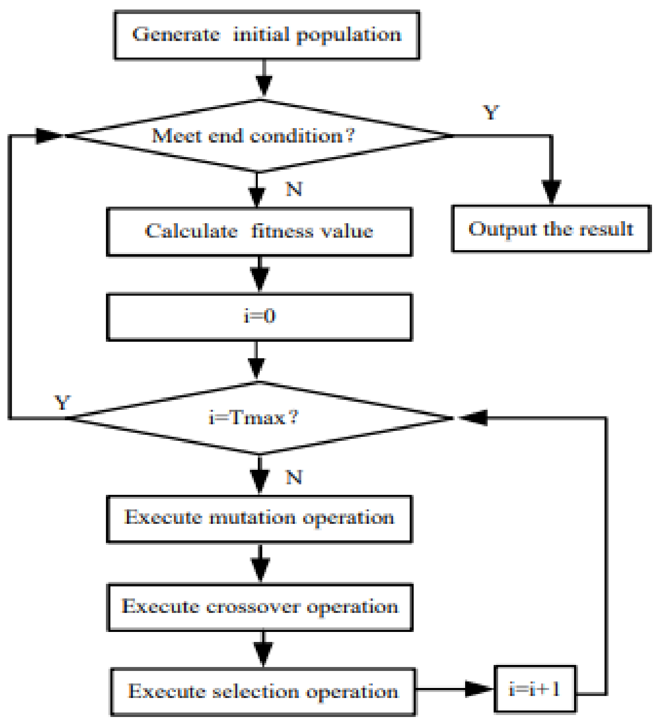

Figure 1. The Flow of DE Algorithm

Performance of the

ENSEMBLED ALGORITHM MVMO-RCEDUMDA-HyDE

to be known