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GIRCEDUMDA: Grouped Importance-based Ring Cellular Encode-Decode UMDA

Algorithm 1: Grouped importance Ring Cellular Encode-Decode UMDA

Input: c - number of cells, m - size of the cells,
$maxIt$ - maximum iteration, l - number of elitist individuals
s - number of selected individuals, g - number of groups
r - neighborhood ratio, q - additional occurrence
k - number of codes, $minB$ - vector of min bounds
$maxB$ - vector of max bounds, $\vec{d}$ - dimension of groups
$\vec{w}$ - grouped importance weights initial as 1.

Output: X_{best} - best solution

```
t ← 1
Pop ← Create Ring cellular structure of c cells of size m, divide into g groups
foreach cell do
    Pop(cell) ← m individuals generated randomly in [minB,maxB]
while t ≤ maxIt do
    Select globally l elitist individuals
    foreach cell do
        M ← the s best individuals in neighborhood(cell,r)
        eM ← encode(M, k, minB, maxB)
        Estimate the single marginal distribution p(x) from eM
        P(x) ← scale (p(x), q, W)
        eC ← c new individuals generating according to P(x)
        C ← decode (eC, k, minB, maxB)
        Insert C in the same cell of an auxiliary population auxPop
    Replace the Pop with auxPop
    x_best ← the local best individual in Pop
    Include the elitist l individuals, replacing the individuals in their positions
    t ← t + 1
    while t ≤ g + 1 do
        ΔOF ← the group g = t − 1 iteration(x_best_t, x_best_{t−1})
    S ← rank(ΔOF, d⃗)
    W ← allocate importance weights(S, w⃗)
X_best ← the global best individual in Pop
```

GIRCEDUMDA grounded in the optimization potential of each group, proposes “grouped importance weights” to refine the probability estimates of population. Additionally, utilizing a cellular structure for decentralization and discretization helps reduce the search space. It's an enhancement by RCEDUMDA [1].

main innovetions:

- Identifying the grouped sensitivity disparities of decision variables toward the objective function, leverage intergenerational difference calculations to ascertain "grouped importance weights." This approach aims to evaluate the potential for improvement within distinct groups.
- By introducing “group importance weights”, we adaptively allocate computational resources to the most promising search regions, significantly improving search efficiency and population diversity.

related references:

[1]Rodríguez-González, A. Y., Barajas, S., Aranda, R., Martínez-López, Y., Quintana, J. M. (2021, July). Ring Cellular Encode-Decode UMDA: Simple is effective. In Proceedings of the 2021 Genetic and Evolutionary Computation Conference Companion. doi: 10.1145/3449726.3463278

[2]Almeida, José, et al. "Guidelines for SSCI 2025 Competition Evolutionary Computation in the Energy Domain: 2025 Edition of the Risk-based Energy Scheduling." (2024).

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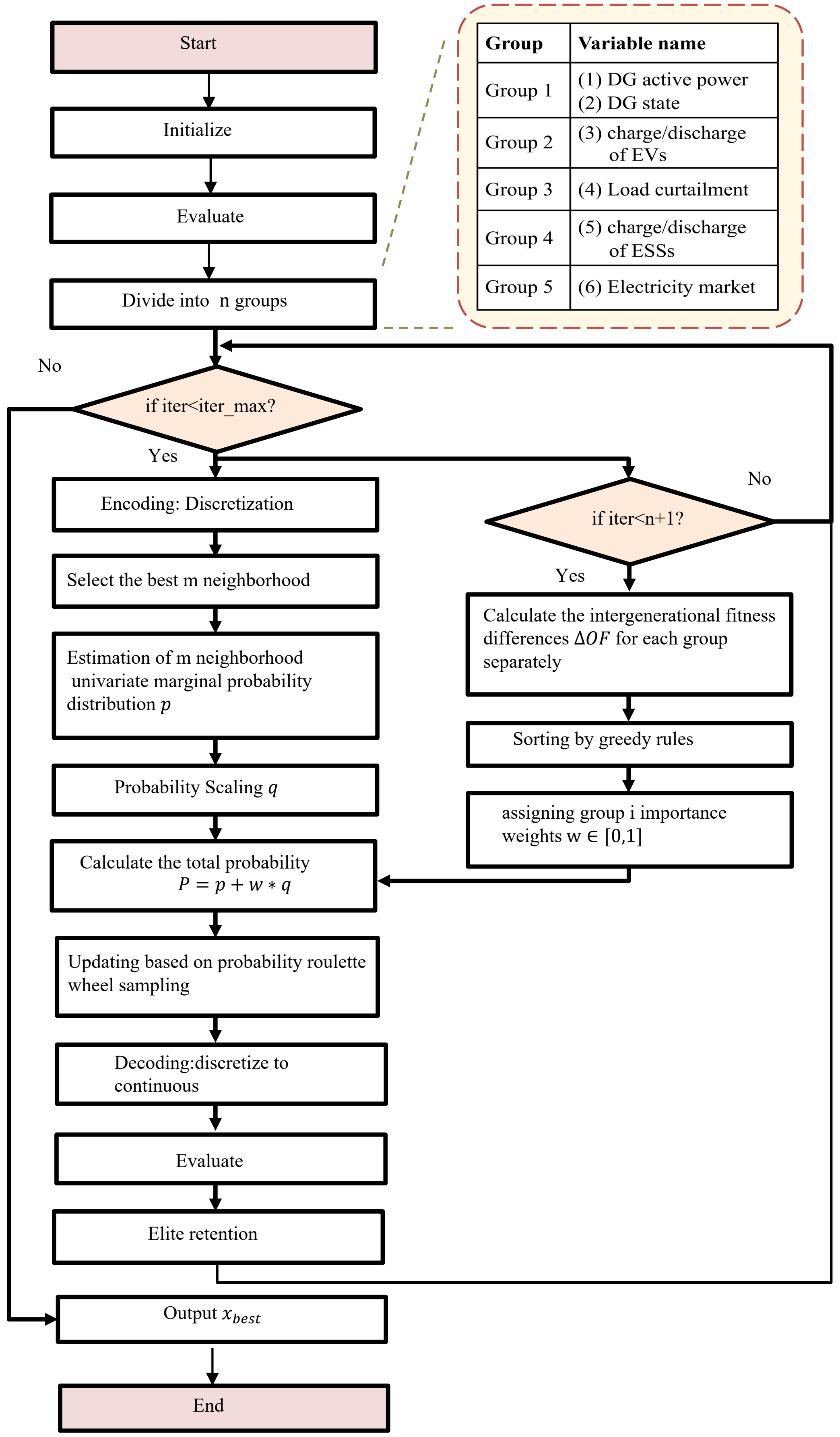

Group	Variable name
Group 1	(1) DG active power (2) DG state
Group 2	(3) charge/discharge of EVs
Group 3	(4) Load curtailment
Group 4	(5) charge/discharge of ESSs
Group 5	(6) Electricity market

algorithm details:

- Uses a cellular ring structure for partitioning the population into many small sub-populations or cells.
- Group and measure each group's potential for optimization.
- Transforms the continuous variables into categorical ones (encoding), thereby narrowing the search scope, and subsequently reverts these categorical variables back to continuous form (decoding).
- Consider optimization potential and group dimensions to assign "grouped importance weights," thereby adjusting scale probabilities with precision. In order to guide the search direction towards regions more likely to find better solutions.
- 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.

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