Hybrid Algorithms

Hybrid Algorithms

- For the population-based optimization methods, the terms exploration and exploitation have been playing an important role in describing the working of an algorithm.
- Use of existing information is known as '**exploitation**'.
- Generation of new solutions in the search space is termed as '**exploration**'.

Hybrid Algorithms

- Any selection procedure in the algorithm is generally characterized as exploitation because the fitness (information) of the individuals is used to determine whether or not an individual should be exploited.
- As exploitation and exploration are the opposing forces, its **balance** is required for the algorithm to search for the global optimum solutions.

Hybrid Algorithms

- In ABC, a new solution vector is calculated using the current solution and a randomly chosen solution from the population indicates the explorative ability of the algorithm.
- Moreover, a fitness-based probabilistic selection scheme is used in the ABC algorithm which indicates the exploitation tendency of the algorithm.

HPABC

- HPABC is developed to combine the advantages of both ABC and PSO.

START

Initialize Population size, number of generations, value of w, c_1 and c_2, $V_{\max}$ and range of design variables.
Generate the initial population and evaluate the fitness for each individual

HPABC

For $i = 1$ to *Population size*

Produce new solutions for the employed bees and evaluate them
$v_{ij} = x_{ij} + R_{ij}(x_{ij} - x_{kj})$
Replace new solution if it is better than the previous one

End

HPABC

For i = 1 to Population size

Calculate the velocity of each solution (Eq. 2.11)
Check the obtained velocity for the limit ($V_{\max}$)
Produce new solutions (Eq. 2.12)
Replace new solution if it is better than the previous

End

$$V_{i+1} = w^* V_i + c_1^* r_1^* (pBest_i - X_i) + c_2^* r_2^* (gBest_i - X_i)$$

End

$$X_{i+1} = X_i + V_{i+1}$$

STOP

HBABC

- **ABC** is good at **exploring** the search space and locating the region of global minimum.
- On the other hand, **BBO** has a good **exploitation** searching tendency for global optimization.
- Based on these considerations, in order to maximize the exploration and the exploitation a HBABC approach is proposed which combines the strength of **ABC and BBO**.

HBABC

START

Initialize Population size, number of generations, immigration rates, emigration rates, mutation rate and range of design variables.

Generate the initial population and evaluate the fitness for each individual

For i = 1 to number of generations

For i = 1 to *Population size*

Produce new solutions for the employed bees and evaluate them
$v_{ij} = x_{ij} + R_{ij}(x_{ij} - x_{kj})$

Replace new solution if it is better than the previous one

End

HBABC

For each individual, map the fitness to the number of species
Calculate the immigration rate λ_i and the emigration rate μ_i for each
For $i = 1$ to *Population size*

Select X_i with probability proportional to λ_i
if rand(0, 1) $< \lambda_i$
For $j = 1$ to N

Select X_j with probability proportional to μ_j
if rand(0, 1) $< \mu_j$
Randomly select a variable σ from X_j
Replace the corresponding variable in X_i with σ
Endif
Endif
End
Replace new solution if it is better than the previous one
End
End
STOP

HDABC

- ABC and DE have different searching capability and the searching mechanism.
- Both the algorithms are good at **exploring** the search space.
- HDABC is developed to combine the advantages of both **ABC and DE**.

HDABC

START

Initialize Population size, number of generations, value of F, and C and range of design variables.

Generate the initial population and evaluate the fitness for each individual

For i = 1 to number of generations

For i = 1 to *Population size*

Produce new solutions for the employed bees and evaluate them
$v_{ij} = x_{ij} + R_{ij}(x_{ij} - x_{kj})$

Replace new solution if it is better than the previous one

End

HDABC

For i = 1 to *Population size*

Generate mutant vector by using three randomly selected solutions $v_{i,m} = x_{i,3} + F(x_{i,1} - x_{i,2})$

Generate trial vector based on crossover probability

If trial vector is better than the current target vector, replace the current solution with the trial solution.

End

End

STOP

HGABC

- **ABC** is good in the **exploration** of the search space while **GA** uses **both exploration and exploitation** for finding the solution.
- HGABC is developed to combine the advantages of both **ABC and GA**.

HGABC

START

Initialize Population size, number of generations, crossover probability, mutation probability and range of design variables.

Generate the initial population and evaluate the fitness for each individual

For i=1 to number of generations

For $i = 1$ to *Population size*

Produce new solutions for the employed bees and evaluate them $v_{ij} = x_{ij} + R_{ij}(x_{ij} - x_{kj})$

Replace new solution if it is better than the previous one

End

HGABC

For $i = 1$ to Population size

  Update solutions by using crossover according to crossover probability
  Update solutions by using mutation according to mutation probability
  Replace solutions if it is better than the existing

End

End
STOP

HGABC eliminates the proportional selection for the onlooker bees and also the scout bees. Solution is updated after the employed bee phase by following the search mechanism of genetic algorithm and hence it combines the strength of both the algorithms.

For further read

1. Rao, R. Venkata, and Vimal J. Savsani. *Mechanical design optimization using advanced optimization techniques*. Springer Science & Business Media, 2012.

Thank you