

Real power loss reduction by arctic char algorithm

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ABSTRACT

This work presents Arctic Char Algorithm (ACA) for solving optimal reactive power problem. In North America movement of Arctic char phenomenon is one among the twelve-monthly innate actions. Deeds of Arctic char have been imitated to design the algorithm. In stochastic mode solutions are initialized with one segment on every side of to the route ascendancy; particularly in between lower bound and upper bounds. Previous to the movement, Arctic char come to a decision about the passageway based on their perception. This implies stochastic mix up of control parameters to push the Arctic char groups (preliminary solution) in mutual pathway (evolutionary operators). Projected Arctic Char Algorithm (ACA) has been tested in standard IEEE 14,300 bus test system and simulation results show the projected algorithm reduced the real power loss extensively.

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1. INTRODUCTION

Reactive power problem plays a key role in secure and economic operations of power system. Optimal reactive power problem has been solved by variety of types of methods [1-6]. Nevertheless, numerous scientific difficulties are found while solving problem due to an assortment of constraints. Evolutionary techniques [7-16] are applied to solve the reactive power problem, but the main problem is many algorithms get stuck in local optimal solution & failed to balance the Exploration & Exploitation during the search of global solution. This work presents Arctic Char Algorithm (ACA) for solving optimal reactive power problem. In North America movement of Arctic char phenomenon is one among the twelve-monthly innate actions. Through mountain streams millions of Arctic chars will move for spawning. During the movement starving bears, human fishers and waterfalls are generally significant threats they have to face. In this work deed of Arctic char has been imitated to design the algorithm. In stochastic mode solutions are initialized with one segment on every side of to the route ascendancy; particularly in between lower bound and upper bounds. Projected Arctic Char Algorithm (ACA) has been tested in standard IEEE 14,300 bus test system and simulation results show the projected algorithm reduced the real power loss extensively.

2. PROBLEM FORMULATION

Objective of the problem is to reduce the true power loss:

$$F = P_L = \sum_{k \in \text{Nbr}} g_k (V_i^2 + V_j^2 - 2V_i V_j \cos \theta_{ij}) \quad (1)$$

Voltage deviation given as follows:

$$\mathbf{F} = \mathbf{P}_L + \omega_v \times \mathbf{Voltage\ Deviation} \quad (2)$$

Voltage deviation given by:

$$\mathbf{Voltage\ Deviation} = \sum_{i=1}^{N_{pq}} |V_i - 1| \quad (3)$$

Constraint (Equality)

$$\mathbf{P}_G = \mathbf{P}_D + \mathbf{P}_L \quad (4)$$

Constraints (Inequality)

$$\mathbf{P}_{gslack}^{\min} \leq \mathbf{P}_{gslack} \leq \mathbf{P}_{gslack}^{\max} \quad (5)$$

$$\mathbf{Q}_{gi}^{\min} \leq \mathbf{Q}_{gi} \leq \mathbf{Q}_{gi}^{\max}, \mathbf{i} \in \mathbf{N}_g \quad (6)$$

$$\mathbf{V}_i^{\min} \leq \mathbf{V}_i \leq \mathbf{V}_i^{\max}, \mathbf{i} \in \mathbf{N} \quad (7)$$

$$\mathbf{T}_i^{\min} \leq \mathbf{T}_i \leq \mathbf{T}_i^{\max}, \mathbf{i} \in \mathbf{N}_T \quad (8)$$

$$\mathbf{Q}_c^{\min} \leq \mathbf{Q}_c \leq \mathbf{Q}_c^{\max}, \mathbf{i} \in \mathbf{N}_C \quad (9)$$

3. ARCTIC CHAR ALGORITHM

In North America movement of Arctic char phenomenon is one among the twelve-monthly innate actions. Through mountain streams millions of Arctic chars will move for spawning. During the movement starving bears, human fishers and waterfalls are generally significant threats they have to face. In this work deed of Arctic char has been imitated to design the algorithm.

In stochastic mode solutions are initialized with one segment on every side of to the route ascendancy; particularly in between lower bound and upper bounds. Solutions are initialized arbitrary mode with reverence to the solution space.

$$\text{Preliminary solution} = \text{lower bound} + \text{random} * (\text{upper bound} - \text{lower bound}) \quad (10)$$

Previous to the movement, Arctic char come to a decision about the passageway based on their perception. This implies stochastic mix up of control parameters to push the Arctic char groups (preliminary solution) in mutual pathway (evolutionary operators).

$$\text{Distribution of solution} : \begin{cases} N_{A_1} = [\mu * AC_s] \\ N_{A_2} = AC_s - N_{A_1} \end{cases} \quad (11)$$

Where N_{A_1} is the total number of Arctic char groups which pass through ocean and ponds, N_{A_2} is the total number of Arctic char group transit through forest area and mountain valley, AC_s is the total number of Arctic char groups which partake in the relocation and μ is Distribution factor is symbolizes the Arctic char intuition.

Crossing of ocean, lakes and ponds has been scientifically modeled as,

$$\begin{cases} Y_N = Y_F + \delta(t, (ub - Y_F)) \\ Y_N = Y_F + \delta(t, (y_F - \text{lower bound})) \end{cases} \quad (12)$$

Where t symbolizes the present iteration number, Y_N symbolize a new-fangled perceive region (fresh solution) and Y_F shows the previous area of the explore convey (preceding solution). $\delta(y, z)$ is computed by,

$$\delta(y, z) = z * \text{random} * \left(1 - \frac{y}{T}\right)^b \quad (13)$$

Where T indicates maximum number of iterations, b is an arbitrary number normally larger than value 1

Chief hunters discover the regions with a satisfactory Arctic char concentration (solution fitness). Subsequent to that, they notify the engaged agent to make use of close by area to discover additional concentrated regions (solution with elevated fitness). This operation has been precisely defined by,

$$Y_R = \beta * (Y_{M1} - Y_{M2}) + Y_{M1} \quad (14)$$

Where β is a arbitrary number which span from 0 and 1 with consistent distribution, Y_R stand for the freshly spotted solution by the engaged agent, Y_{M1} is the solution acquired by the primary key hunter and Y_{M2} is the solution acquired by the subsequent one.

Second operator simulates the bears hunt line of assault. Naturally they notify each other when they find an appropriate region. When they discover a region with superior Arctic char concentration, they notify to other bears. It expressed as,

$$Y_B = \cos(\varphi) * (BT_R - CL_R) + BT_R \quad (15)$$

Where Y_B symbolizes the new-fangled spotted area, BT_R is the most excellent accounted area by the hunting squad, CL_R is the present area for which the bears have determined to execute the local exploitation and φ is a capricious angle with a segment on every side of 0 to 360 degrees. $\cos(\varphi)$ articulate the bears to their objective.

End of the repositioning, stay alive Arctic char will get together in their mark for spawning. In Arctic char this normal event is replicated through a compilation stem. After Arctic char surpass through their passageway (operator's performance), the Arctic char subgroups (solutions) are composed in a exclusive stem. Solutions are extorted from mutual operators and make an exclusive population. At this condition, the proposed algorithm has reached the ending stage of the primary iteration.

- Step1. Determine the population size, solution space, total number of variables, iterations
- Step2. Regulate the Arctic char subgroups chaotically
- Step3. Depending on migration μ passageway is chosen
- Step4. Compute the fitness of hunted Arctic char
- Step5. Arctic char used for spawn has been rumple together
- Step6. If yes obtain the global solution or else go to step number 3.

4. SIMULATION RESULTS

At first in standard IEEE 14 bus system the validity of the proposed Arctic Char Algorithm (ACA) has been tested & comparison results are presented in Table 1.

Table 1. The validity of the proposed Arctic Char Algorithm (ACA)

Control variables	ABCO [17]	IABCO [17]	ACA
V1	1.06	1.05	1.00
V2	1.03	1.05	1.05
V3	0.98	1.03	1.03
V6	1.05	1.05	1.01
V8	1.00	1.04	0.90
Q9	0.139	0.132	0.100
T56	0.979	0.960	0.900
T47	0.950	0.950	0.900
T49	1.014	1.007	1.000
Ploss (MW)	5.92892	5.50031	4.1652

Then IEEE 300 bus system [18] is used as test system to validate the performance of the Arctic Char Algorithm (ACA). Table 2 shows the comparison of real power loss obtained after optimization.

Table 2. Comparison of real power loss

Parameter	Method EGA [19]	Method EEA [19]	Method CSA [20]	ACA
PLOSS (MW)	646.2998	650.6027	635.8942	616.2596

5. CONCLUSION

In this work Arctic Char Algorithm (ACA) successfully solved the optimal reactive power problem. Deeds of Arctic char have been imitated to design the algorithm. End of the repositioning, stay alive Arctic char will get together in their mark for spawning. In Arctic char this normal event is replicated through a compilation stem. After Arctic char surpass through their passageway (operator's performance), the Arctic char subgroups (solutions) are composed in a exclusive stem. Solutions are extorted from mutual operators and make an exclusive population. Projected Arctic Char Algorithm (ACA) has been tested in standard IEEE 14,300 bus test system and simulation results show the projected algorithm reduced the real power loss extensively.

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