Real Power Loss Reduction by Extreme Learning Machine based - Xiphias and Gilt-head bream Optimization Algorithms

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Abstract: In this paper Extreme Learning Machine based - Xiphias Optimization Algorithm (ELMXOA) and Gilt-head bream Optimization Algorithm (ELMGHO) applied to solve the problem. Entrant solutions in the proposed procedure are Xiphias and populace in the exploration zone, capriciously created. Gilt-head bream Optimization Algorithm designed by imitating the actions of Gilt-head bream’s supportive stalking physiognomies. In cluster mode, the Gilt-head bream hunt the victim, it is entitled as key cluster (population), and additional cluster is termed as sub – population. Proposed ELM based - Xiphias Optimization Algorithm (ELMXOA) and Gilt-head bream Optimization Algorithm (ELMGHO) corroborated in IEEE 300 and 220 KV systems.

Keywords: Extreme Learning Machine; Xiphias; Gilt-head bream

Introduction

Real power loss reduction forecasted as one of the farfetched circumstances for safe and fiscal action of system [4-6]. In this paper ELM based - Xiphias Optimization Algorithm (ELMXOA) and Gilt-head bream Optimization Algorithm (ELMGHO). Naturally, Xiphias moves in cluster mode in the direction of Alewife for hunting. Drive of Xiphias is extraordinary, it spasm the Alewife energetically. Xiphias normal actions emulated to design the algorithm. Entrant solutions in the proposed procedure are Xiphias and populace in the exploration zone capriciously created. Gilt-head bream Optimization Algorithm designed by imitating the actions of Gilt-head bream’s supportive stalking physiognomies. In cluster mode, the Gilt-head bream hunt the victim, it is entitled as key cluster (population), and additional cluster is termed as sub – population. Once the victim touches, the clogged Gilt-head bream at that time routinely it will converted into turn as fresh tracker. At any period tracker will become clogged and vice versa rendering to victim location and circumstances. Exploration region designed on the root of stalking zone.

Problem Formulation

Power loss minimization defined by

\[
\begin{align*}
\text{Min } & \bar{F}(\bar{d}, \bar{e}) \\
F_1 & = P_{\text{Minimize}} = \text{Minimize}\left[\sum_{m=1}^{NTL} G_{m} [V_i^2 + V_j^2 - 2 \times V_i V_j \cos \theta_{ij}] \right] \\
F_2 & = \text{Minimize}\left[\sum_{i=1}^{NLB} |V_{Lk} - V_{Lk}^{\text{desired}}|^2 + \sum_{i=1}^{NG} |Q_{KG} - Q_{KG}^{\text{Lim}}|^2 \right] \\
F_3 & = \text{Minimize } \text{L}_{\text{Maximum}} \\
\end{align*}
\]

Parity constraints

\[
\begin{align*}
0 &= PD_i - PD_i - V_i \sum_{j \in ENb} V_j G_{ij} \cos[\theta_i - \theta_j] + B_{ij} \sin[\theta_i - \theta_j] \\
0 &= QD_i - QD_i - V_i \sum_{j \in ENb} V_j G_{ij} \sin[\theta_i - \theta_j] + B_{ij} \cos[\theta_i - \theta_j] \\
\end{align*}
\]
Disparity constraints

\[ p_{\text{minimum}} \leq p_{\text{slack}} \leq p_{\text{maximum}} \quad (7) \]

\[ Q_{\text{gi}}^{\text{minimum}} \leq Q_{\text{gi}} \leq Q_{\text{gi}}^{\text{maximum}}, \quad i \in N_g \quad (8) \]

\[ V_{L_i}^{\text{minimum}} \leq V_{L_i} \leq V_{L_i}^{\text{maximum}}, \quad i \in N_L \quad (9) \]

\[ T_{i}^{\text{minimum}} \leq T_{i} \leq T_{i}^{\text{maximum}}, \quad i \in N_T \quad (10) \]

\[ Q_{C}^{\text{minimum}} \leq Q_{C} \leq Q_{C}^{\text{maximum}}, \quad i \in N_C \quad (11) \]

\[ |S_{L_i}| \leq S_{L_i}^{\text{maximum}}, \quad i \in N_{TL} \quad (12) \]

\[ V_{G_i}^{\text{minimum}} \leq V_{G_i} \leq V_{G_i}^{\text{maximum}}, \quad i \in N_g \quad (13) \]

\[ \text{MOF} = F_1 + r_1 F_2 + u F_3 = F_1 + \left[ \sum_{i=1}^{N_L} x_i [V_{L_i} - \left( V_{L_i}^{\text{min}} \right)^2 + \sum_{i=1}^{N_G} r_{g} \left[ Q_{G_i} - Q_{G_i}^{\text{min}} \right] ] \right] + r_1 F_3 \quad (14) \]

**Extreme Learning Machine based - Xiphias Optimization Algorithm and Gilt-head bream Optimization Algorithm**

In this paper ELM based - Xiphias Optimization Algorithm (ELMXOA) and Gilt-head bream Optimization Algorithm (ELMGO) is applied to solve the problem. Entrant solutions in the proposed procedure are Xiphias and populace in the exploration zone capriciously created. Naturally, Xiphias moves in cluster mode in the direction of Alewife for hunting 10-12. Drive of Xiphias is extraordinary, it spasm the Alewife energetically. Xiphias normal actions emulated to design the algorithm. Entrant solutions in the proposed procedure are Xiphias and populace in the exploration zone capriciously created.

Gilt-head bream Optimization Algorithm designed by imitating the actions of Gilt-head bream’s supportive stalking physiognomies. In cluster mode, the Gilt-head bream hunt the victim, it is entitled as key cluster (population), and additional cluster is termed as sub – population. In Extreme learning machine 8, 9 the associating input to hidden layer delineated as,

\[
W_{gt} = \begin{bmatrix}
    w_{gt1}^T \\
    w_{gt2}^T \\
    \vdots \\
    w_{gtL}^T
\end{bmatrix} = \begin{bmatrix}
    w_{g11} & \ldots & w_{g1n} \\
    \vdots & \ddots & \vdots \\
    w_{gL1} & \ldots & w_{gLn}
\end{bmatrix}
\quad (15)
\]

\[
O(D_1, \ldots D_L; \omega_1, \ldots, \omega_L; \alpha_1, \ldots, \alpha_L) = \\
\begin{bmatrix}
    k(\alpha_2D_1 + \alpha_1) & \ldots & k(\alpha_2D_L + \alpha_1) \\
    \vdots & \ddots & \vdots \\
    k(\alpha_2D_N + \alpha_1) & \ldots & k(\alpha_2D_N + \alpha_L)
\end{bmatrix}
\quad (16)
\]

In the probing zone existing location of the ith associate is defined as,

\[ X_{\text{Xiphias}_i,k} \in \mathbb{R}(i = 1, 2, \ldots, n) \quad (17) \]

Capricious location and fitness of the Xiphias throughout process is defined as,

\[ X_{\text{Xiphias}_i} = \\
\begin{bmatrix}
    f(X_{\text{Xiphias}_{i,1}}) \\
    f(X_{\text{Xiphias}_{i,2}}) \\
    \vdots \\
    f(X_{\text{Xiphias}_{i,d}})
\end{bmatrix} \\
\begin{bmatrix}
    F_{\text{Xiphias}_{1}} \\
    F_{\text{Xiphias}_{2}} \\
    \vdots \\
    F_{\text{Xiphias}_{n}}
\end{bmatrix}
\quad (18) \]

Alewife is intermixed in algorithm and in the exploration area it will be in reeling mode. At that juncture the Alewife location and aptness value is determined by,

\[ X_{\text{Alewife}_i} = \\
\begin{bmatrix}
    f(A_{\text{Alewife}_{i,1}}) \\
    f(A_{\text{Alewife}_{i,2}}) \\
    \vdots \\
    f(A_{\text{Alewife}_{i,d}})
\end{bmatrix} \\
\begin{bmatrix}
    F_{A_{\text{Alewife}_{1}}} \\
    F_{A_{\text{Alewife}_{2}}} \\
    \vdots \\
    F_{A_{\text{Alewife}_{n}}}
\end{bmatrix}
\quad (19) \]

The location of the loftier Xiphias and the wounded Alewife which own the superlative aptness rate in the ith iteration is itemized as \( U_{\text{Loffier Xiphias}} \) and \( U_{\text{Wounded Alewife}} \). In the proposed approach the fresh location of Xiphias designated as,
\[
U_{\text{fresh, Xiphias}}^i = U_{\text{Loftier, Xiphias}}^i - \lambda_i \times \left( \text{Rand}(0,1) \times \left( \frac{U_{\text{Loftier, Xiphias}}^i + U_{\text{wounded, Alewife}}^i}{2} - U_{\text{preceding, Xiphias}}^i \right) \right)
\]

(20)

\[
\lambda_i = 2 \times \text{Rand}(0,1) \times \text{victim compactness} - \text{victim compactness}
\]

\[
\text{victim compactness} = 1 - \left( \frac{\text{Sum of Xiphias}}{\text{Sum of Xiphias + amount of Alewife}} \right)
\]

(21)

\[
U_{\text{fresh, P}}^i = \text{Rand} \times \left( U_{\text{Loftier, Xiphias}}^i - U_{\text{preceding, Xiphias}}^i + \text{Xiphias spasm control} \right)
\]

(22)

\[
\text{spasm control} = l \times (2 \times \text{iter} \times \epsilon)
\]

\[
\alpha = \text{amount of Alewife} \times \text{spasm control}
\]

\[
\beta = \text{parameters} \times \text{spasm control}
\]

Proportional probabilities of Xiphias to quest fresh Alewife is demarcated as,

\[
U_{\text{Xiphias}}^i = U_{\text{Alewife}}^i \text{ if } f(\text{Alewife}_i) < f(\text{Xiphias}_i)
\]

(23)

i. Start

ii. Input the data

iii. Engender the Test and Training set

iv. Create the Xiphias population capriciously

v. Engender the Alewife population

vi. Factor spasm control values are chosen

vii. Compute the Fitness rate of Xiphias

viii. Calculi the fitness value of Alewife

ix. Premium Xiphias, is selected as loftier Xiphias and Designate the wounded Alewife while stop condition not satisfied

x. Compute the \( \lambda_i \) value

xi. \( \lambda_i = 2 \times \text{Rand}(0,1) \times \text{victim compactness} - \text{victim compactness} \)

xii. Streamline the location of Xiphias

xiii. \( U_{\text{fresh, Xiphias}}^i = U_{\text{Loftier, Xiphias}}^i - \lambda_i \times \left( \text{Rand}(0,1) \times \left( \frac{U_{\text{Loftier, Xiphias}}^i + U_{\text{wounded, Alewife}}^i}{2} - U_{\text{preceding, Xiphias}}^i \right) \right) \)

xiv. \( \lambda_i = 2 \times \text{Rand}(0,1) \times \text{victim compactness} - \text{victim compactness} \)

xv. End for

xvi. Calculate the rate of spasm control

xvii. spasm control = \( l \times (2 \times \text{iter} \times \epsilon) \)

xviii. if spasm control < 0.5 , then compute

xix. \( \alpha = \text{amount of Alewife} \times \text{spasm control} \)

xx. \( \beta = \text{parameters} \times \text{spasm control} \)

xxi. Grounded on the rate of \( \alpha, \beta \); elect the set of Alewife and Location of elected Alewife is rationalised

xxii. \( U_{\text{fresh, P}}^i = \text{Rand} \times \left( U_{\text{Loftier, Xiphias}}^i - U_{\text{preceding, Xiphias}}^i + \text{Xiphias spasm control} \right) \)

xxiii. \( Y_{\text{new, P}}^i = \text{random number} \times \left( Y_{\text{superior, Xiphias}}^i - Y_{\text{previous, P}}^i + \text{Xiphias attack power} \right) \)

xxiv. End if

xxv. Calculate fitness rate of all Alewife

xxvi. If better Alewife population found at that moment exchange a Alewife with wounded Alewife
xxvii. $U_{\text{Xiphas}}^i = U_{\text{Alewife}}^i$ if $f(Alewife_i) < f(Xiphas_i)$

xxviii. Fix Extreme Learning Machine input weights and hidden bias

xxix. Extreme Learning Machine testing

xix. Abolish the startled Alewife from the population and Streamline the premium Xiphas and Alewife

xxi. End if

xxii. End while

xxiii. Return preeminent Xiphas

xxiv. End

Contingent to spatial distribution of the entity’s population and sub clusters are designed. Population of “n” Gilt-head breams (individuals) is \{Gilt – head bream$_{1}$, Gilt – head bream$_{2}$, ..., Gilt – head bream$_{n}$\} has been capriciously created in the exploration region with stated limitations; $L^{\text{max}}$ and $L^{\text{min}}$. Rendering to resolution factors,

\[
\text{Gilt – head bream}_i \in \text{Gilt – head bream} \ ; \ \text{Gilt – head bream}_i = \{\text{Gilt – head bream}^1_i, \text{Gilt – head bream}^2_i, ..., \text{Gilt – head bream}^n_i\} \tag{24}
\]

\[
\text{Gilt – head bream}^j_i = \text{Rand} \cdot (L^{\text{max}}_j - L^{\text{min}}_j) + L^{\text{min}}_j ; i = 1,2, ..., m ; j = 1,2, ..., n \tag{25}
\]

In the proposed procedure in each bunch $i$ will own $\mathcal{V}_{ir}$ (tracker Gilt-head bream) and $\mathcal{V}_{cd}$ (clogged Gilt-head bream). File set will be designed on the foundation of the populace of Gilt-head bream and file points \{Gilt – head bream$_{1}$, Gilt – head bream$_{2}$, ..., Gilt – head bream$_{n}$\} and aligned inaccuracy $\delta_r$ in the bunch $b_r$ is defined as,

\[
e(b_r) = \sum_{\text{Gilt – head bream} \in b_r} ||\text{Gilt – head bream} - \delta_r||^2 \ ; \ b = 1,2, ..., k \tag{26}
\]

\[
E(b) = \sum_{r=1}^{k} e(b_r) \tag{27}
\]

At that point the fresh position of the tracker Gilt-head bream is specified as,

\[
\text{Fresh Location} \ (\mathcal{V}_{ir}^{t+1}) = \text{Present location} \ (\mathcal{V}_{ir}^t) + \alpha \oplus L(\beta) \tag{28}
\]

For harmonizing the exploration and exploitation flights, $\beta$ will be employed in suitable method to boost the examination in the exploration region [13, 14].

\[
\beta = 2.00 + \frac{0.0031}{t_{\text{max}}/10} \tag{29}
\]

\[
R(SS) = \alpha \oplus L(\beta) \sim \alpha \left( \frac{u}{\sqrt{1+\pi}} \right) \cdot (\mathcal{V}_{ir}^t - \mathcal{V}_{\text{best}}^t) \tag{30}
\]

Fresh location of the tracker Gilt-head bream rendering to Levy is specified as,

\[
\text{fresh} (\mathcal{V}_{ir}^{t+1}) = \mathcal{V}_{ir}^t + \text{Rand} (SS) \tag{31}
\]

Rendering to global best the fresh location of tracker Gilt-head bream is specified as,

\[
\mathcal{V}_{\text{best}}^{t+1} = \mathcal{V}_{\text{best}}^t + SS' \tag{32}
\]

\[
SS' = \alpha \left( \frac{u}{\sqrt{1+\pi}} \right) \tag{33}
\]

Rendering to the location of the victim, the Fresh location of the $\mathcal{V}_{cd}^{t+1}$ (clogged Gilt-head bream) is demarcated as,

\[
\mathcal{V}_{cd}^{t+1} = \text{Dis}_{cd} \cdot e^{bp} \cdot \cos 2\pi\rho + \mathcal{V}_{ir}^t \tag{34}
\]

Contemporary expanse between clogged and tracker Gilt-head bream is demarcated as,

\[
\text{Dist}_{cd} = |\text{rand} \cdot \mathcal{V}_{ir} - \mathcal{V}_{cd}^t| \tag{35}
\]

\[
\{\mathcal{V}_{ir}, \mathcal{V}_{cd}^t\} \in b_r \tag{36}
\]

Exploration region is designed on the root of stalking zone and change of zone is defined as,

\[
\text{Gilt – head bream}^{t+1}_n = \frac{\mathcal{V}_{\text{best}}^{\text{Gilt – head bream}} + \mathcal{V}_{\text{cd}}^{t+1}}{2} \tag{37}
\]
a. Start
b. Input the data
c. Engender the Test and Training set
d. Set the parameter values
e. Engender the population
f. \( \text{Gilt} - \text{head bream}_i = \{ \text{Gilt} - \text{head bream}_1, \text{Gilt} - \text{head bream}_2, \ldots, \text{Gilt} - \text{head bream}_n \} \)
g. Compute the Fitness value of each entity
h. Identify the \( \forall \text{best} \)
i. Form the bunch \( \{ \text{bunch}_1, \text{bunch}_2, \ldots, \text{bunch}_r \} \)
j. For every bunch identify \( \forall_{tr} \) (tracker Gilt-head bream) and \( \forall_{cd} \) (clogged Gilt-head bream)
k. While \( (t < t_{max}) \)
l. For every \( \text{bunch}_r \) do
m. Apply stalking plan for tracker Gilt-head bream
n. Apply clogged plan for clogged Gilt-head bream
o. Compute the fitness value for all Gilt-head bream
p. If \( \forall_{cd} \) (clogged Gilt-head bream) has improved fitness than \( \forall_{tr} \) (tracker Gilt-head bream), at that moment exchange the protagonists by streamlining \( \forall_{tr} \) (tracker Gilt-head bream)
q. End If
r. If \( \forall_{tr} \) (tracker Gilt-head bream) has superior fitness value than \( \forall_{best} \)
s. Streamline \( \forall_{best} \)
t. End If
u. If \( \forall_{tr} \) (tracker Gilt-head bream) fitness value not enhanced then ,
v. \( u \leftarrow u + 1 \)
w. End If
x. Fix Extreme Learning Machine input weights and hidden bias
y. Extreme Learning Machine testing
z. If \( u > \lambda \)
aa. Apply a plan for shifting the zone
bb. \( u \leftarrow 0 \)
cc. End If
dd. End For
e. \( t \leftarrow t + 1 \)
ff. End While
gg. Return the \( \forall_{best} \)
hh. End

Simulation Results

Projected ELM based - Xiphias Optimization Algorithm (ELMXOA) and Gilt-head bream Optimization Algorithm (ELMGHO) substantiated in IEEE 300 bus system [3]. Table I shows assessment. IEEE 300-bus system encompasses 69-generators, 60-LTCs, 304- transmission lines, and 195- loads.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Loss (MW)</th>
<th>POD (PU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPAI [1]</td>
<td>396.9830</td>
<td>5.93240</td>
</tr>
<tr>
<td>IMPAII [1]</td>
<td>397.2360</td>
<td>5.94160</td>
</tr>
<tr>
<td>IMPSA [1]</td>
<td>397.9020</td>
<td>5.96130</td>
</tr>
<tr>
<td>ELMXOA</td>
<td>390.8970</td>
<td>5.81540</td>
</tr>
<tr>
<td>ELMGHO</td>
<td>390.7860</td>
<td>5.80990</td>
</tr>
</tbody>
</table>

Projected ELM based - Xiphias Optimization Algorithm (ELMXOA) and Gilt-head bream Optimization Algorithm (ELMGHO) verified in 220 KV (UETN) [5]. Table II shows the tangible power loss and deviancy review.

<table>
<thead>
<tr>
<th>Method</th>
<th>Loss (MW)</th>
<th>POD (PU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IMPPSO[4]</td>
<td>32.314</td>
<td>0.5800</td>
</tr>
<tr>
<td>IMPBBA [4]</td>
<td>33.875</td>
<td>0.6327</td>
</tr>
<tr>
<td>MPBBA [4]</td>
<td>30.786</td>
<td>0.6751</td>
</tr>
<tr>
<td>ELMXOA</td>
<td>27.108</td>
<td>0.5793</td>
</tr>
<tr>
<td>ELMGHO</td>
<td>27.092</td>
<td>0.5776</td>
</tr>
</tbody>
</table>

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Projected ELM based - Xiphias Optimization Algorithm (ELMXOA) and Gilt-head bream Optimization Algorithm (ELMGHO) compared with other standard algorithms; IMPAI [1], IMPAI [1], IMPSA [1], IMPALO [2]. Projected ELMXOA and ELMGHO algorithms reduced the power loss effectively. Power oddness also reduced to minimum level by Projected ELMXOA and ELMGHO algorithms proficiently while equated to other indicated procedures.

Conclusion

In this paper Extreme Learning Machine based - Xiphias Optimization Algorithm (ELMXOA) and Gilt-head bream Optimization Algorithm (ELMGHO) has been successfully solved the power loss lessening problem. Entrant solutions in the proposed procedure are Xiphias and populace in the exploration zone capriciously created. In cluster mode, the Gilt-head bream hunt the victim, it is entitled as key cluster (population), and additional cluster is termed as sub – population. Once the victim touches, the clogged Gilt-head bream at that time routinely it will converted into turn as fresh tracker. Proposed ELM based - Xiphias Optimization Algorithm (ELMXOA) and Gilt-head bream Optimization Algorithm (ELMGHO) authenticated in IEEE 300 and 220 KV systems. Projected ELMXOA and ELMGHO algorithms reduced the power loss effectively.

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