

LEVY BASED PHRYNOSOMA DOUGLASSII SWARM, ALASHAN WAPITI OPTIMIZATION, FOREST PONY ALGORITHM AND PANTHERA TIGRIS CORBETTI SEARCH FOR TRUE POWER LOSS REDUCTION IN ELECTRICAL SYSTEM

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Abstract

Lévy based *Phrynosoma douglassii* inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and *Panthera Tigris corbetti* optimization (PTC) algorithm are applied to solve the true power loss reduction problem. Camouflage, colour changing, blood spouting and squirt out protection methods of *Phrynosoma douglassii* are scientifically formulated in the LPD algorithm. Due to Camouflage action, *Phrynosoma douglassii* alter its body colorant by flattering luminous to evade exposure to the predators. AWO algorithm is formulated based on the natural breeding procedure of Alashan wapiti. There are dual key breeding periods for Alashan wapiti. In the rutting season Alashan wapiti herd alienated into dissimilar folks of numerous proportions. FP algorithm replicates the foraging area nearby Forest Pony with coefficient and scientific execution of foraging. Forest Ponies from upper layer of the organized matrix are designated as Alpha cluster of Forest Ponies. In PTC, during initial period, the location of population associates is rationalized grounded on picking and bout on the prey. This period sources abrupt and widespread vicissitudes in the location of population associates, and as a consequence, it upsurges the aptitude of the global examination and exploration of the procedure in precise glance over of the examination region. Lévy based *Phrynosoma douglassii* inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and *Panthera Tigris corbetti* optimization (PTC) algorithm are validated in IEEE 118, 300, 354 systems.

Keywords: *Phrynosoma douglassii*; Alashan wapiti; Forest Pony; *Panthera Tigris corbetti*

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Introduction

True power loss reduction is an important problem in power system operation and control. Several investigators around the biosphere applying numerous techniques (Kumar *et al.*, 2020a; Kumar *et al.*, 2020b; Omelchenko *et al.*, 2020; Pullabhatla *et al.*, 2020; Kumar *et al.*, 2021; Singh *et al.*, 2021; Awaar *et al.*, 2022; Baba *et al.*, 2022; Kumar *et al.*, 2022; Malik *et al.*, 2022; Kumar *et al.*, 2024; Pushkarna *et al.*, 2024) for solving the power dispatch and other related problems. In this paper Phrynosoma douglassii inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and Panthera Tigris corbetti optimization (PTC) algorithm are applied to solve the true power loss reduction problem. Camouflage, colour changing, blood spouting and squirt out protection methods of Phrynosoma douglassii are scientifically formulated to design the Lévy based Phrynosoma douglassii inspired optimization (LPD) algorithm. Montanucci 2015 conducted a taxonomic revision of the Phrynosoma douglassii classes, Christian 1998 done research on Phrynosoma douglassii at high elevation, Powell *et al.*, 1998 conducted study on the distribution of Phrynosoma douglassii, Powell and Russell 1984 done research on sexual dimorphism of Phrynosoma douglassii. Camouflage, colour changing, blood spouting and squirt out protection methods of Phrynosoma douglassii are scientifically formulated in the design. In the Camouflage activity; Phrynosoma douglassii alter its body colorant by flattering luminous to evade exposure to the predators. Phrynosoma douglassii alter the intensity of the colour by melanophores rendering to the conditions. The intensity of the colour varies with reference to the temperature. Blood spouting of the Phrynosoma douglassii is one among the defensive strategy and with reference to the position of the predator Phrynosoma douglassii will spout the blood from the eyes. Squirt out is a defense method of Phrynosoma douglassii define about the rapid arbitrary movement of the Phrynosoma douglassii from the predator to the safest environment. Alashan wapiti optimization (AWO) algorithm is formulated based on the natural breeding process of Alashan wapiti (Polziehn and Strobeck, 2002). There are dual key breeding periods for Alashan wapiti; rutting and calving. In the period of rutting, Alashan wapiti habitually utilize zones round the fresh water and inclined to cradle in hefty wooden logs hours to hours in each day. In the period of August to October, rutting season will occur. During this period Alashan wapiti herd alienated into dissimilar

folks of numerous proportions. This partition is grounded on belligerent behaviour among the male. Fight will occur between the Alashan wapiti males to win the chance of matting with female. Dominant male will the chance of matting with female Alashan wapiti. During the calving period, female Alashan wapiti breeds new calves. Throughout the calving period, female Alashan wapiti is protect the new calves from threat. After this period different herds are merged and again most dominant Alashan wapiti will be selected during the rutting season for mating. In this paper three periods; rutting, calving and selection (mating) are considered in the design of the algorithm. In the procedure, population is divided into set of clusters; each cluster will have one dominant male Alashan wapiti and associated with cohorts in the rutting period. The quantity of cohorts is defined based on the fitness rate of the dominant male Alashan wapiti. Each cluster will produce novel solutions grounded on the dominant male Alashan wapiti and cohorts in the calving period. The associates of all clusters including dominant male Alashan wapiti, cohorts, are united and the fittest population is designated in the selection period. In the rutting season Alashan wapiti herd alienated into dissimilar folks of numerous proportions. This partition is grounded on belligerent behaviour. Fight will occur between the males to win the chance of mating with female. Dominant male will mate with the female Alashan wapiti. Roulette-wheel selection is applied to creating clusters. In each cluster there will be one dominant male and associated cohort during rutting period. The probability of assigning the dominant male for each cluster is computed. Forest Pony Optimization (FPO) algorithm is based on the natural actions of Forest Pony (Tyler, 1972). FPO emulates the social deeds of ponies at diverse years and it described as Foraging (F), order(O), Affability (A), Replication (R), Security procedure (S) and wandering (W). Forest ponies' response is likenesses of the circumstance when they have been are prey for slayers and usually Forest ponies will protect themselves by displaying the fight-or-flight reaction. Main response is to spurt out of danger. In PTC, population entails of Panthera Tigris corbetti optimization, which pursue superior solutions by altering their positions in the examination region. Each Panthera Tigris (Zhang, 2019) corbetti optimization is an associate of the projected procedure's population. In initial period, the location of population associates is rationalized grounded on picking and bout on the prey. This period sources abrupt and widespread vicissitudes in

the location of population associates, and as a consequence, it upsurges the aptitude of the global examination and exploration of the procedure in precise glance over of the examination region. Projected prey locations for each *Panthera tigris* corbetti optimization are designated from other associates of the population that have an improved objective functional rate than that associate. In the subsequent period the location of the population associates is rationalized grounded on the pursuit procedure.

Lévy based *Phrynosoma douglassii* inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and *Panthera Tigris* corbetti optimization (PTC) algorithm are validated in IEEE 118, 300, 354 systems.

Problem Formulation

Real power loss reduction is defined as,

$$\text{Min } \tilde{F}(\bar{g}, \bar{h}) \quad (1)$$

$$M(\bar{g}, \bar{h}) = 0$$

$$N(\bar{g}, \bar{h}) = 0$$

$$g = [VL_{G1}, \dots, VL_{GN_g}; QC_1, \dots, QC_{N_c}; T_1, \dots, T_{N_T}]$$

$$h = [PG_{slack}; VL_1, \dots, VL_{N_{load}}; QG_1, \dots, QG_{N_g}; SL_1, \dots, SL_{N_T}]$$

$$Q_c \rightarrow \text{reactive power compensator}$$

$$T \rightarrow \text{Transformer tap}$$

$$V_g \rightarrow \text{Generator voltage}$$

$$PG_{slack} \rightarrow \text{Slack generator}$$

$$V_L \rightarrow \text{Voltage in transmission lines}$$

$$Q_G \rightarrow \text{Reactive power generator}$$

$$F_1 = P_{Min} = \text{Min} \left[\sum_m^{NTL} G_m [V_i^2 + V_j^2 - 2 * V_i V_j \cos \theta_{ij}] \right]$$

$$F_2 = \text{Min} \left[\sum_{l=1}^{NLB} |V_{Lk} - V_{Lk}^{desired}|^2 + \sum_{i=1}^{Ng} |Q_{Gk} - Q_{KG}^{lim}|^2 \right]$$

$$F_3 = \text{Minimize } L_{MaxImum}$$

$$S_L \rightarrow \text{Apparent power}$$

$$L_{Max} = \text{Max}[L_j]; j = 1; N_{LB}$$

$$\begin{cases} L_j = 1 - \sum_{i=1}^{NPV} F_{ji} \frac{V_i}{V_j} \\ F_{ji} = -[Y_1]^1 [Y_2] \end{cases}$$

$$L_{Max} = \text{Max} \left[1 - [Y_1]^{-1} [Y_2] \times \frac{V_i}{V_j} \right]$$

$$0 = PG_i - PD_i - V_i \sum_{j \in N_B} V_j [G_{ij} \cos[\theta_i - \theta_j] + B_{ij} \sin[\theta_i - \theta_j]]$$

$$0 = QG_i - QD_i - V_i \sum_{j \in N_B} V_j [G_{ij} \sin[\theta_i - \theta_j] + B_{ij} \cos[\theta_i - \theta_j]]$$

$$NB \text{ is the number of buses}$$

$$PG, QG \rightarrow \text{real and reactive power}$$

$$G_{ij}, B_{ij} \rightarrow \text{mutual conductance and susceptance}$$

PD, QD $\rightarrow$ real and reactive load

$$P_{gsl}^{min} \leq P_{gsl} \leq P_{gsl}^{max} \quad (2)$$

Reactive power generation (QGi)

$$Q_{gi}^{min} \leq Q_{gi} \leq Q_{gi}^{max}, i \in N_g \quad (3)$$

Load bus voltage (VLi)

$$VL_i^{min} \leq VL_i \leq VL_i^{max}, i \in NL \quad (4)$$

Transformers tap setting (Ti)

$$T_i^{min} \leq T_i \leq T_i^{max}, i \in N_T \quad (5)$$

Switchable reactive power compensations (QCi)

$$Q_c^{min} \leq Q_c \leq Q_c^{max}, i \in N_c \quad (6)$$

$$|SL_i| \leq S_{Li}^{max}, i \in N_{TL} \quad (7)$$

Generator bus voltage (VGi)

$$VG_i^{min} \leq VG_i \leq VG_i^{max}, i \in N_g \quad (8)$$

$$\text{Multi objective fitness (MOF)} = F_1 + r_1 F_2 + u F_3 = F_1 + \left[\sum_{i=1}^{NL} x_v [VL_i - VL_i^{min}]^2 + \sum_{i=1}^{NG} r_g [QG_i - QG_i^{min}]^2 \right] + r_f F_3$$

$$VL_i^{minimum} = \begin{cases} VL_i^{max}, & VL_i > VL_i^{max} \\ VL_i^{min}, & VL_i < VL_i^{min} \end{cases} \quad (9)$$

$$QG_i^{minimum} = \begin{cases} QG_i^{max}, & QG_i > QG_i^{max} \\ QG_i^{min}, & QG_i < QG_i^{min} \end{cases} \quad (10)$$

Lévy based *Phrynosoma douglassii* inspired optimization algorithm

Camouflage, colour changing, blood spouting and spurt out protection methods of *Phrynosoma douglassii* are scientifically formulated to design the Lévy based *Phrynosoma douglassii* inspired optimization (LPD) algorithm. In the Camouflage activity, the *Phrynosoma douglassii* alter its body colorant by flattering luminous to evade exposure to the predators. The *Phrynosoma douglassii* alter the intensity of the colour by melanophores rendering to the conditions. Blood spouting and spurt out protection method of the *Phrynosoma douglassii* is scientifically designed in the procedure. At first in the Camouflage activity, the *Phrynosoma douglassii* alter its body colorant by flattering luminous to evade exposure to the predators. Cartesian and polar coordinates are utilized in the scientific formulation of the Camouflage activity.

$$x^* = \begin{cases} +x, R \\ -x, G \end{cases} \quad (11)$$

$$y^* = \begin{cases} +y, Y \\ -y, B \end{cases} \quad (12)$$

$x^*, y^* \rightarrow$ coordinates

$R \rightarrow$ red colour

$G \rightarrow$ green colour

$Y \rightarrow$ yellow colour

$B \rightarrow$ blue colour

Coordinates transformation is defined as,

$$z^* = \sqrt{x^{*2} - y^{*2}} \quad (13)$$

The angle is defined as,

$$P = \arccos\left(\frac{y^*}{x^*}\right) \quad (14)$$

Colour variation of *Phrynosoma douglassii* is defined as,

$$CV_1 = y_a^* - x_b^* - x_c^* + y_d^* \quad (15)$$

$$CV_2 = y_a^* - x_b^* - x_c^* - y_d^* \quad (16)$$

$$CV = y_a^* - x_b^* \pm [x_c^* - y_d^*] \quad (17)$$

$CV \rightarrow$ Colour variation

With reference to the search agent position, Colour variation of *Phrynosoma douglassii* is defined as,

$$Q_i(t+1) = Q_b(t) + \left(\varphi - \frac{\varphi \cdot t}{T}\right) [CV] \quad (18)$$

$$CV = y_a^* - x_b^* \pm [x_c^* - y_d^*]$$

$Q_i(t+1) \rightarrow$ location of search agent

$Q_b(t) \rightarrow$ best location of search agent

$\varphi = 2$

$t \rightarrow$ current iteration

$T \rightarrow$ maximum iteration

Phrynosoma douglassii alter the intensity of the colour by melanophores rendering to the conditions. The intensity of the colour varies with reference to the temperature.

$$Q_w(t) = Q_b(t) + \frac{1}{2} L_1 \sin(Q_{r_1}(t) - Q_{r_2}(t)) - (-1)^{\tau} \frac{1}{2} L_2 \sin(Q_{r_3}(t) - Q_{r_4}(t)) \quad (19)$$

$$r_1, r_2, r_3, r_4 \in [0,1]$$

$L_1, L_2 \rightarrow$ Light colour intensity

$\tau \rightarrow$ binary value

$$Q_w(t) = Q_b(t) + \frac{1}{2} D_1 \sin(Q_{r_1}(t) - Q_{r_2}(t)) - (-1)^{\tau} \frac{1}{2} D_2 \sin(Q_{r_3}(t) - Q_{r_4}(t)) \quad (20)$$

$$r_1, r_2, r_3, r_4 \in [0,1]$$

$D_1, D_2 \rightarrow$ Dark colour intensity

$\tau \rightarrow$ binary value

$Q_w(t), Q_b(t) \rightarrow$ worst and best values

Blood spouting of the *Phrynosoma douglassii* is one among the defensive strategy and with reference to the position of the predator *Phrynosoma douglassii* will spout the blood from the eyes. The position and velocity is defined as,

$$V_o = V_o \cos(\beta) t + (V_o \sin(\beta) t - \frac{1}{2} g t^2) \quad (21)$$

$$Q_i(t+1) = \left[V_o \cos\left(\beta \frac{t}{T}\right) + \delta\right] Q_b(t) + \left[V_o \sin\left(\beta \frac{t}{T}\right) - g + \delta\right] Q_i(t) \quad (22)$$

$Q_i(t+1) \rightarrow$ new location of search agent

$Q_b(t) \rightarrow$ best location of search agent

$$\beta = \frac{\pi}{2}, \delta = IE - 6.0, V_o = 1, g = 0.009807 \text{ km/s}^2$$

Spurt out defense method of *Phrynosoma douglassii* define about the rapid arbitrary movement of the *Phrynosoma douglassii* from the predator to the safest environment. In this procedure Lévy based movement of the *Phrynosoma douglassii* is defined as follows,

$$Q_i(t+1) = Q_b(t) + \text{Lévy}(d) \left(\frac{1}{2} - \epsilon\right) Q_i(t) \quad (23)$$

$\text{Lévy}(d) \rightarrow$ Lévy dimension

$$L(s) \sim |s|^{-1-\beta}$$

$$0 < \beta < 2$$

$$L(s, \gamma, \mu) = \begin{cases} \sqrt{\frac{\gamma}{2\pi}} & \exp\left[-\frac{\gamma}{2(s-\mu)}\right] \frac{1}{(s-\mu)^{3/2}} \\ 0 & \text{if } s \leq 0 \end{cases}$$

$$F(k) = \exp[-\alpha|k|^{\beta}], 0 < \mu < s < \infty$$

$$R \in [0,1]$$

Colour changing aspect of the *Phrynosoma douglassii* with reference to fitness value is defined as,

$$C(i) = \frac{F_{\max} - F(i)}{F_{\max} - F_{\min}} \quad (24)$$

$F \rightarrow$ fitness value

$$Q_i(t) = Q_b(t) + \frac{1}{2} [Q_{r_1}(t) - (-1)^{\tau} R_{r_2}(t)] \quad (25)$$

- a. Start
- b. Fix the parameter
- c. Engender the population
- d. Define the camouflage activity
- e. Apply the Cartesian and polar coordinates
- f. $x^* = \begin{cases} +x, R \\ -x, G \end{cases}$
- g. $y^* = \begin{cases} +y, Y \\ -y, B \end{cases}$
- h. Define the Coordinates transformation and angle
- i. $z^* = \sqrt{x^{*2} - y^{*2}}$
- j. $P = \arccos\left(\frac{y^*}{x^*}\right)$
- k. Determine the Colour variation of Phrynosoma douglassii
- l. $CV_1 = y_a^* - x_b^* - x_c^* + y_d^*$
- m. $CV_2 = y_a^* - x_b^* - x_c^* - y_d^*$
- n. $CV = y_a^* - x_b^* \pm [x_c^* - y_d^*]$
- o. $Q_i(t+1) = Q_b(t) + \left(\varphi - \frac{\varphi \cdot t}{T}\right) [CV]$
- p. Define the intensity of the colour
- q. $Q_w(t) = Q_b(t) + \frac{1}{2} L_1 \sin(Q_{r_1}(t) - Q_{r_2}(t)) - (-1)^{\tau} \frac{1}{2} L_2 \sin(Q_{r_3}(t) - Q_{r_4}(t))$
- r. $Q_w(t) = Q_b(t) + \frac{1}{2} D_1 \sin(Q_{r_1}(t) - Q_{r_2}(t)) - (-1)^{\tau} \frac{1}{2} D_2 \sin(Q_{r_3}(t) - Q_{r_4}(t))$
- s. Define the Blood spouting behaviour of the Phrynosoma douglassii
- t. $V_o = V_o \cos(\beta) t + (V_o \sin(\beta) t - \frac{1}{2} g t^2) Q_i(t+1) = [V_o \cos(\beta \frac{t}{T}) + \delta] Q_b(t) + [V_o \sin(\beta \frac{t}{T}) - g + \delta] Q_i(t)$
- u. Define the Lévy based movement of the Phrynosoma douglassii
- v. $Q_i(t+1) = Q_b(t) + \text{Lévy}(d) \left(\frac{1}{2} - \epsilon\right) Q_i(t)$
- w. Determine the colour changing rendering to fitness value
- x. $C(i) = \frac{F_{max} - F(i)}{F_{max} - F_{min}}$
- y. $Q_i(t) = Q_b(t) + \frac{1}{2} [Q_{r_1}(t) - (-1)^{\tau} R_{r_2}(t)]$
- z. End for
- aa. $t = t + 1$
- bb. Output the best solution
- cc. End

Alashan wapiti optimization algorithm

Alashan wapiti optimization (AWO) algorithm is formulated based on natural breeding process of Alashan wapiti. There are dual key breeding periods for Alashan wapiti; rutting and calving. In the period of rutting, Alashan wapiti habitually utilize zones round the fresh water, and inclined to cradle in hefty wooden logs hours to hours in each day. The period of rutting is around 30 to 50 days depending on the geographical conditions. During the calving period, female Alashan wapiti breeds new calves. After this

period different herds will be merged and again most dominant Alashan wapiti will be selected during the rutting season for mating. In this paper three periods; rutting, calving and selection are considered in the design of the algorithm. Population of Alashan wapiti is generated as,

$$A = \begin{bmatrix} A_1 \\ \vdots \\ A_i \\ \vdots \\ A_N \end{bmatrix}_{N \times m} = \begin{bmatrix} a_{1,1} & \cdots & a_{1,m} \\ \vdots & \ddots & \vdots \\ a_{N,1} & \cdots & a_{N,m} \end{bmatrix} \quad (26)$$

$A \rightarrow$ population matrix
 $N \rightarrow$ population member
 $m \rightarrow$ variables

$$a_{i,j} = lb_j + R(ub_j - lb_j) \quad (27)$$

$ub_j, lb_j \rightarrow$ limits

$R \in [0,1]$

Value of the objective function is calculated as,

$$F = \begin{bmatrix} F_1 \\ \vdots \\ F_i \\ \vdots \\ F_N \end{bmatrix}_{N \times 1} = \begin{bmatrix} F(A_1) \\ \vdots \\ F(A_i) \\ \vdots \\ F(A_N) \end{bmatrix}_{N \times 1} \quad (28)$$

In the rutting season Alashan wapiti herd alienated into dissimilar folks of numerous proportions. Fight will occur between the Alashan wapiti males to win the chance of matting with female. Dominant male will the chance of matting with female Alashan wapiti.

$$C = \arg \min_{j \in \{1,2,\dots,C\}} f(z^j) \quad (29)$$

$C \rightarrow$ male Alashan wapiti
 $z^j \rightarrow$ dominant male

Roulette-wheel selection is applied to create clusters. In each cluster possess one dominant male Alashan wapiti and associated cohorts in the rutting period. The probability of assigning the dominant male for each cluster is computed as follows,

$$p_j = \frac{f(z^j)}{\sum_{k=1}^C f(z^k)} \quad (30)$$

$p_j \rightarrow$ The probability of assigning the dominant male
 $k \rightarrow$ cluster

Roulette-wheel selection applied in the process.

- a. $p_j = \frac{f(z^j)}{\sum_{k=1}^C f(z^k)}$
- b. Fix $U = 0, j = 0$
- c. while($u \leq r$) do

- d. $j = j + 1$
- e. $U = U + p_j$
- f. *end while*
- g. $z_k = j$
- h. *end for*
- i. *end*

In the calving period female Alashan wapiti breeds new calves. Throughout the calving period, female Alashan wapiti protect the new calves from threat.

$$z_i^j(t+1) = z_t^j(t) + \beta \cdot (z_t^k(t) - z_t^j(t)) \quad (31)$$

$$\beta \in [0,1]$$

$$z_i^j(t+1) \rightarrow \text{calves Alashan wapiti}$$

Alashan wapiti calves possess the attributes of male and female Alashan wapiti. It is defined as,

$$z_i^j(t+1) = z_t^j(t) + \gamma (z_i^{c_j}(t) - z_t^j(t)) + \delta (z_t^r(t) - z_t^j(t)) \quad (32)$$

$$z_i^j(t+1) \rightarrow \text{attributes of calves}$$

$$c_j \rightarrow \text{cluster}$$

$$r \rightarrow \text{random}$$

$$r \in C$$

$$\gamma, \delta \in [0,2]$$

In selection segment, after the breeding season, there will be merging of the clusters. Again in the next rutting season dominant male will be chosen and clusters will be formed sequentially. Each generation fittest Alashan wapiti will be replaced.

$$z^j = z_{temp}^j \quad (33)$$

- a. Start
- b. Set the values
- c. Engender the population

$$d. A = \begin{bmatrix} A_1 \\ \vdots \\ A_i \\ \vdots \\ A_N \end{bmatrix}_{N \times m} = \begin{bmatrix} a_{1,1} & \cdots & a_{1,m} \\ \vdots & \ddots & \vdots \\ a_{N,1} & \cdots & a_{N,m} \end{bmatrix}$$

- e. Compute the fitness value

$$f. F = \begin{bmatrix} F_1 \\ \vdots \\ F_i \\ \vdots \\ F_N \end{bmatrix}_{N \times 1} = \begin{bmatrix} F(A_1) \\ \vdots \\ F(A_i) \\ \vdots \\ F(A_N) \end{bmatrix}_{N \times 1}$$

- g. Define the rutting period

$$h. C = \arg \min_{j \in \{1,2,\dots,C\}} f(z^j)$$

- i. Determine the probability of assigning the dominant male for each cluster

- j. $p_j = \frac{f(z^j)}{\sum_{k=1}^C f(z^k)}$
- k. *Apply the Roulette – wheel selection*
- l. $p_j = \frac{f(z^j)}{\sum_{k=1}^C f(z^k)}$
- m. *Fix* $U = 0, j = 0$
- n. *while* ($u \leq r$) *do*
- o. $j = j + 1$
- p. $U = U + p_j$
- q. *end while*
- r. $z_k = j$
- s. *end for*
- t. *Define the calving period*
- u. $z_i^j(t+1) = z_t^j(t) + \beta \cdot (z_t^k(t) - z_t^j(t))$
- v. Define the attributes of calves
- w. $z_i^j(t+1) = z_t^j(t) + \gamma (z_i^{c_j}(t) - z_t^j(t)) + \delta (z_t^r(t) - z_t^j(t))$
- x. Determine the selection segment
- y. $z^j = z_{temp}^j$
- z. $t = t + 1$
- aa. Output the best solution
- bb. End

Forest Pony Optimization Algorithm

Forest Pony Optimization (FPO) algorithm is based on the natural actions of Forest Pony. FPO emulates the social deeds of ponies at diverse years and it described as Foraging (F), order(O), Affability (A), Replication (R), Security procedure (S) and wandering (W). These actions of ponies applied at every iteration and it has been mathematically described as,

$$Y_n^{Iteration, Year} = \overline{VL}_n^{Iteration, Year} + Y_n^{(Iteration-1), Year}; Year = Alpha, Beta, Gamma, Delta \quad (34)$$

Where $Y_n^{Iteration, Year}$ symbolize the position of the “n” Forest Pony, “Year” shows the oldness kind measured for the forest Pony, “Iteration” indicates the present iteration, $\overline{VL}_n^{Iteration, Year}$ designate the velocity vector of the Forest Pony. Naturally life span of Forest Pony is 28 - 32 years and in this design Alpha symbolizes the Forest ponies in the range of more than 16 years, Beta epitomizes the Forest Ponies in the age phase of 11-16 years, Gamma represents the Forest Ponies in the age phase of 7-11 years and Delta symbolizes the Forest ponies in the age phase of 0-6 years. A complete matrix of reactions is accompanied per iteration to choose the age of Forest Ponies and with reference to this the matrix can be systematized grounded on the preminent retorts and

subsequently, the leading 10 % of the Forest Ponies from upper layer of the organized matrix are designated as Alpha cluster of Forest Ponies. Then the subsequent 20 % are in the Beta cluster. Remaining 30 and 40 Percentage are nominated as Gamma and Delta Forest Ponies. The phases to pretend the actions of the Forest Ponies are scientifically employed to identify the velocity (motion) vector. In every sequence of FPO algorithm with reference to the different years (ages) of forest ponies the motion vector is defined as,

$$\overline{VL}_n^{Iteration, Alpha} = \vec{F}_n^{Iteration, Alpha} + \vec{S}_n^{Iteration, Alpha} \quad (35)$$

$$\overline{VL}_n^{Iteration, Beta} = \vec{F}_n^{Iteration, Beta} + \vec{O}_n^{Iteration, Beta} + \vec{A}_n^{Iteration, Beta} + \vec{S}_n^{Iteration, Beta} \quad (36)$$

$$\overline{VL}_n^{Iteration, Gamma} = \vec{F}_n^{Iteration, Gamma} + \vec{O}_n^{Iteration, Gamma} + \vec{A}_n^{Iteration, Gamma} + \vec{R}_n^{Iteration, Gamma} + \vec{S}_n^{Iteration, Gamma} + \vec{W}_n^{Iteration, Gamma} \quad (37)$$

$$\overline{VL}_n^{Iteration, Delta} = \vec{F}_n^{Iteration, Delta} + \vec{R}_n^{Iteration, Delta} + \vec{W}_n^{Iteration, Delta} \quad (38)$$

Forest Ponies are continuous foraging in nature, which nourish on floras, meadow, etc. Forest Ponies forage on grasslands for 17 to 21 hours per day, and their cessation time is small. This technique of unhurried foraging is named unremitting consumption. FPO algorithm facsimiles the foraging area nearby each Forest Pony with coefficient (h) and scientific execution of foraging (F) is described as follows,

$$\vec{F}_n^{Iteration, Year} = h_{iteration}(upper\ bound\ (ub) + Random \cdot lower\ bound\ (lb)) \left[Y_n^{(Iteration-1)} \right]; Year = Alpha, Beta, Gamma, Delta; R \in [0,1]; lb = 0.950\ and\ ub = 1.050; h = 1.50 \quad (39)$$

$$h_n^{iteration, Year} = h_n^{(iteration-1), Year} \times \omega_h \quad (40)$$

Where $\vec{F}_n^{Iteration, Year}$ indicate the ith Forest pony's motion variable

Forest Ponies are not in liberty mode with reference to individual. They live life by following a spearhead and most senior forest pony will be positioned as leader. This segment is symbolized as Order (O). In this paper coefficient (j) to be the propensity of the Forest ponies to follow the spearhead and it mathematically defined as,

$$\vec{O}_n^{Iteration, Year} = j_n^{iteration, Year} \left[Y_n^{(iteration-1)} \right]; Year = Alpha, Beta\ and\ Gamma \quad (41)$$

$$j_n^{iteration, Year} = j_n^{(iteration-1), Year} \times \omega_j \quad (42)$$

Where $\vec{O}_n^{Iteration, Year}$ designates the paraphernalia of most excellent Forest Pony on the velocity variable and $Y_n^{(iteration-1)}$ symbolizes the position of the finest Forest Pony

Forest Ponies in necessitate of affable time and occasionally live with other faunae. Flock life has placed Forest Ponies in secure mode because they are actuality hunted by slayers. Diversity upsurges the probabilities of existence and makes to spurt out of danger. And this phase Affability (A) is mathematically described as,

$$\vec{A}_n^{Iteration, Year} = a_n^{Iteration, Year} \left[\left(\frac{1}{NFP} \sum_{k=1}^{NFP} Y_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right]; Year = Beta, Gamma \quad (43)$$

$$a_n^{iteration, Year} = a_n^{(iteration-1), Year} \times \omega_a \quad (44)$$

Where $\vec{A}_n^{Iteration, Year}$ designates the ith Forest pony's Affability motion vector, NFP is the number of Forest Pony, 'a' is the coefficient for the Beta and gamma horses

Forest Ponies emulate (Replication (R)) each other, and they acquire each other's behaviours and very particularly young Forest Pony will mimic the other Forest ponies' actions but when it grows this aptitude will be vanished. This Replication (R) segment mathematically defined as,

$$\vec{R}_n^{Iteration, Year} = r_n^{Iteration, Year} \left[\left(\frac{1}{NFP.B} \sum_{k=1}^{NFP.B} \hat{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right]; Year = Gamma \quad (45)$$

$$r_n^{iteration, Year} = r_n^{(iteration-1), Year} \times \omega_r \quad (46)$$

Where $\vec{R}_n^{Iteration, Year}$ specifies the movement of ith Forest Pony in the direction of average most excellent Forest Ponies with reference to $\hat{Y}$ locations and $NFP.B$ symbolizes the total number of Forest ponies in most excellent locations. Forest ponies' response is likenesses of the circumstance when they have been are prey for slayers and usually Forest ponies will protect themselves by displaying the fight-or-flight reaction. Main response is to spurt out of danger.

And this segment Security procedure (S) is mathematically defined as,

$$\vec{S}_n^{Iteration, Year} = -S_n^{Iteration, Year} \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} \check{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right]; Year = Alpha, Beta and Gamma \quad (47)$$

$$S_n^{iteration, Year} = S_n^{(iteration-1), Year} \times \omega_s \quad (48)$$

Where $\vec{S}_n^{Iteration, Year}$ symbolizes the i th Forest ponies' movement from poorest locations with reference to $\check{Y}$ positions and NFP . Represents the total number of Forest ponies in poorest locations. Forest ponies' wander and consume the food from one zone to others regions. With inquisitiveness Forest ponies will make the movement in exploration of food and It has been designated as wandering (W) in this design which has been mathematically defined as,

$$\vec{W}_n^{Iteration, Year} = W_n^{Iteration, Year} \cdot Random Y^{(Iteration-1)}; Year = Gamma and Beta \quad (49)$$

$$W_n^{iteration, Year} = W_n^{(iteration-1), Year} \times \omega_w \quad (50)$$

Where $\vec{W}_n^{Iteration, Year}$ indicates the i th Forest ponies' arbitrary velocity Vector in local exploration and in each sequence ω_w will act as reduction variable for $W_n^{iteration, Year}$. Then the common velocity of all the *Alpha, Beta, Gamma, Delta* Forest ponies are mathematically described and velocity of Delta Forest ponies' in the age phase of 0-6 years as follows

$$\vec{VL}_n^{Iteration, Delta} = \left[F_n^{(iteration-1), Delta} \cdot \omega_h (upper bound (ub) + Random \cdot lower bound(lb)) [Y_n^{(Iteration-1)}] \right] + \left[a_n^{(Iteration-1), Delta} \omega_a \left[\left(\frac{1}{NFP.B} \sum_{k=1}^{NFP.B} \hat{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right] + w_n^{(Iteration-1), Delta} \omega_w \cdot Random Y^{(Iteration-1)} \right] \quad (51)$$

Velocity of Gamma Forest Ponies in the age phase of 7-11 years as follows

$$\vec{VL}_n^{Iteration, Gamma} = \left[F_n^{(iteration-1), Gamma} \cdot \omega_f (upper bound (ub) + Random \cdot lower bound(lb)) [Y_n^{(Iteration-1)}] \right] + \left[a_n^{(iteration-1), Gamma} \omega_a \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} \check{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right] + S_n^{(iteration-1), Gamma} \omega_s \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} \check{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right] + \left[W_n^{(iteration-1), Gamma} \omega_w \cdot Random Y^{(Iteration-1)} \right] \quad (52)$$

$$\vec{VL}_n^{Iteration, Beta} = \left[F_n^{(iteration-1), Beta} \cdot \omega_f (upper bound (ub) + Random \cdot lower bound(lb)) [Y_n^{(Iteration-1)}] \right] + \left[a_n^{(iteration-1), Beta} \omega_a \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} \check{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right] + S_n^{(iteration-1), Beta} \omega_s \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} \check{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right] + \left[W_n^{(iteration-1), Beta} \omega_w \cdot Random Y^{(Iteration-1)} \right] \quad (53)$$

Velocity of Beta Forest Ponies in the age phase of 11- 16 years as follows

$$\vec{VL}_n^{Iteration, Alpha} = \left[F_n^{(iteration-1), Alpha} \cdot \omega_f (upper bound (ub) + Random \cdot lower bound(lb)) [Y_n^{(Iteration-1)}] \right] + \left[a_n^{(iteration-1), Alpha} \omega_a \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} \check{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right] + S_n^{(iteration-1), Alpha} \omega_s \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} \check{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right] + \left[W_n^{(iteration-1), Alpha} \omega_w \cdot Random Y^{(Iteration-1)} \right] \quad (54)$$

Velocity of Alpha Forest ponies in the age phase of more than 16 years

$$\vec{VL}_n^{Iteration, Alpha} = \left[F_n^{(iteration-1), Alpha} \cdot \omega_f (upper bound (ub) + Random \cdot lower bound(lb)) [Y_n^{(Iteration-1)}] \right] + \left[a_n^{(iteration-1), Alpha} \omega_a \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} \check{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right] + S_n^{(iteration-1), Alpha} \omega_s \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} \check{Y}_{k=1}^{(Iteration-1)} \right) - Y_n^{(Iteration-1)} \right] + \left[W_n^{(iteration-1), Alpha} \omega_w \cdot Random Y^{(Iteration-1)} \right] \quad (54)$$

In the procedure the Global matrix attained by

$$Y = \begin{bmatrix} Y_{1,1} & \cdots & Y_{1,d} \\ \vdots & \ddots & \vdots \\ Y_{n,1} & \cdots & Y_{n,d} \end{bmatrix}$$

$$Cost\ of\ each\ position\ C(Y) = \begin{bmatrix} cp_1 \\ cp_2 \\ \vdots \\ cp_n \end{bmatrix} \quad (54)$$

$$\text{Global matrix} = [Y \ C(Y)] = \begin{bmatrix} y_{1,1} & \cdots & y_{1,d}cp_1 \\ \vdots & \ddots & \vdots \\ y_{n,1} & \cdots & y_{n,d}cp_2 \end{bmatrix} \quad (55)$$

Over all computational cost

$$= \text{Com.cost} \left(\frac{\text{Iteration}_{\text{maximum}} n^2}{2} + \frac{\text{iteration}_{\text{maximum}} d}{s} \right) \quad (56)$$

Forest Pony Optimization (FPO) algorithm

- Start
- Define the variables
- In the exploration space engender the Forest Ponies population randomly
- With reference to location and objective function compute the fitness values of each Forest Pony
- Determine range (age) of Forest Pony
- Classify the Forest Pony based on age as *Alpha, Beta, Gamma, Delta*

$$\begin{aligned} \vec{VL}_n^{\text{Iteration}, \text{Alpha}} &= \vec{F}_n^{\text{Iteration}, \text{Alpha}} \\ &+ \vec{S}_n^{\text{Iteration}, \text{Alpha}} \\ \vec{VL}_n^{\text{Iteration}, \text{Beta}} &= \vec{F}_n^{\text{Iteration}, \text{Beta}} \\ &+ \vec{O}_n^{\text{Iteration}, \text{Beta}} \\ &+ \vec{A}_n^{\text{Iteration}, \text{Beta}} \\ &+ \vec{S}_n^{\text{Iteration}, \text{Beta}} \\ \vec{VL}_n^{\text{Iteration}, \text{Gamma}} &= \vec{F}_n^{\text{Iteration}, \text{Gamma}} \\ &+ \vec{O}_n^{\text{Iteration}, \text{Gamma}} \\ &+ \vec{A}_n^{\text{Iteration}, \text{Gamma}} \\ &+ \vec{R}_n^{\text{Iteration}, \text{Gamma}} \\ &+ \vec{S}_n^{\text{Iteration}, \text{Gamma}} \\ &+ \vec{W}_n^{\text{Iteration}, \text{Gamma}} \end{aligned}$$

$$\begin{aligned} \vec{VL}_n^{\text{Iteration}, \text{Delta}} &= \vec{F}_n^{\text{Iteration}, \text{Delta}} \\ &+ \vec{R}_n^{\text{Iteration}, \text{Delta}} \\ &+ \vec{W}_n^{\text{Iteration}, \text{Delta}} \end{aligned}$$

- Model the Foraging (F), order(O), Affability (A), Replication (R), Security procedure (S) and wandering (W) actions of Forest Pony

$$\begin{aligned} \vec{F}_n^{\text{Iteration}, \text{Year}} &= h_{\text{iteration}}(\text{upper bound (ub)} + \text{Random} \\ &\cdot \text{lower bound (lb)}) [Y_n^{(\text{Iteration}-1)}]; \text{Year} \\ &= \text{Alpha, Beta, Gamma, Delta}; R \in [0,1]; lb \\ &= 0.950 \text{ and } ub = 1.050; h = 1.50 \\ h_n^{\text{iteration}, \text{Year}} &= h_n^{(\text{iteration}-1), \text{Year}} \times \omega_h \\ \vec{O}_n^{\text{Iteration}, \text{Year}} &= j_n^{\text{iteration}, \text{Year}} [Y_*^{(\text{iteration}-1)} \\ &- Y_n^{(\text{iteration}-1)}]; \text{Year} \\ &= \text{Alpha, Beta and Gamma} \end{aligned}$$

$$\begin{aligned} j_n^{\text{iteration}, \text{Year}} &= j_n^{(\text{iteration}-1), \text{Year}} \times \omega_j \\ \vec{A}_n^{\text{Iteration}, \text{Year}} &= a_n^{\text{Iteration}, \text{Year}} \left[\left(\frac{1}{NFP} \sum_{k=1}^{NFP} Y_k^{(\text{Iteration}-1)} \right) \right. \\ &\left. - Y_n^{(\text{Iteration}-1)} \right]; \text{Year} = \text{Beta, Gamma} \\ \vec{a}_n^{\text{iteration}, \text{Year}} &= a_n^{(\text{iteration}-1), \text{Year}} \times \omega_a \\ \vec{R}_n^{\text{Iteration}, \text{Year}} &= r_n^{\text{Iteration}, \text{Year}} \left[\left(\frac{1}{NFP.B} \sum_{k=1}^{NFP.B} Y_k^{(\text{Iteration}-1)} \right) \right. \\ &\left. - Y_n^{(\text{Iteration}-1)} \right]; \text{Year} = \text{Gamma} \\ \vec{r}_n^{\text{iteration}, \text{Year}} &= r_n^{(\text{iteration}-1), \text{Year}} \times \omega_r \\ \vec{S}_n^{\text{Iteration}, \text{Year}} &= -s_n^{\text{Iteration}, \text{Year}} \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} Y_k^{(\text{Iteration}-1)} \right) \right. \\ &\left. - Y_n^{(\text{Iteration}-1)} \right]; \text{Year} = \text{Alpha, Beta and Gamma} \\ \vec{s}_n^{\text{iteration}, \text{Year}} &= s_n^{(\text{iteration}-1), \text{Year}} \times \omega_s \\ \vec{W}_n^{\text{Iteration}, \text{Year}} &= w_n^{\text{Iteration}, \text{Year}} \\ &\cdot \text{Random } Y^{(\text{Iteration}-1)}; \text{Year} \\ &= \text{Gamma and Beta} \\ w_n^{\text{iteration}, \text{Year}} &= w_n^{(\text{iteration}-1), \text{Year}} \times \omega_w \\ \text{h. Based on the classification of Forest Pony} \\ &\text{apply the velocity factor} \end{aligned}$$

Velocity of Delta Forest ponies' in the age phase of 0-6 years as follows

$$\begin{aligned} \vec{VL}_n^{\text{Iteration}, \text{Delta}} &= \left[F_n^{(\text{iteration}-1), \text{Delta}} \right. \\ &\cdot \omega_h(\text{upper bound (ub)} + \text{Random} \\ &\cdot \text{lower bound (lb)}) [Y_n^{(\text{Iteration}-1)}] \\ &+ \left[a_n^{(\text{Iteration}-1), \text{Delta}} \omega_a \left[\left(\frac{1}{NFP.B} \sum_{k=1}^{NFP.B} Y_k^{(\text{Iteration}-1)} \right) \right. \right. \\ &\left. \left. - Y_n^{(\text{Iteration}-1)} \right] \right] + w_n^{(\text{Iteration}-1), \text{Delta}} \omega_w \\ &\cdot \text{Random } Y^{(\text{Iteration}-1)} \end{aligned}$$

Velocity of Gamma Forest Ponies in the age phase of 7-11 years as follows

$$\begin{aligned}
& \overline{VL}_n^{Iteration, Gamma} \\
&= \left[F_n^{(iteration-1), Gamma} \right. \\
&\cdot \omega_f(\text{upper bound}(ub) + \text{Random} \\
&\cdot \text{lower bound}(lb)) [Y_n^{(iteration-1)}] \\
&+ O_n^{(iteration-1), Gamma} \\
&\cdot \omega_o [Y_n^{(iteration-1)} - Y_n^{(iteration-1)}] + a_n^{(iteration-1), gamma} \\
&\cdot \omega_a \left[\left(\frac{1}{NFP} \sum_{k=1}^{NFP} Y_{k=1}^{(iteration-1)} \right) - Y_n^{(iteration-1)} \right] \\
&+ S_n^{(iteration-1), Gamma} \cdot \omega_r \left[\left(\frac{1}{NFP.B} \sum_{k=1}^{NFP.B} Y_{k=1}^{(iteration-1)} \right) \right. \\
&\left. - Y_n^{(iteration-1)} \right] \\
&+ S_n^{(iteration-1), Gamma} \cdot \omega_s \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} Y_{k=1}^{(iteration-1)} \right) \right. \\
&\left. - Y_n^{(iteration-1)} \right] + \left[W_n^{(iteration-1), gamma} \cdot \omega_w \right. \\
&\left. \cdot R.Y^{(iteration-1)} \right]
\end{aligned}$$

Velocity of Beta Forest Ponies in the age phase of 11- 16 years as follows

$$\begin{aligned}
& \overline{VL}_n^{Iteration, Beta} \\
&= \left[F_n^{(iteration-1), Beta} \right. \\
&\cdot \omega_f(\text{upper bound}(ub) + \text{Random} \\
&\cdot \text{lower bound}(lb)) [Y_n^{(iteration-1)}] + O_n^{(iteration-1), Beta} \\
&\cdot \omega_o [Y_n^{(iteration-1)} - Y_n^{(iteration-1)}] + a_n^{(iteration-1), gamma} \\
&\cdot \omega_a \left[\left(\frac{1}{NFP} \sum_{k=1}^{NFP} Y_{k=1}^{(iteration-1)} \right) - Y_n^{(iteration-1)} \right] \\
&+ S_n^{(iteration-1), Beta} \cdot \omega_s \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} Y_{k=1}^{(iteration-1)} \right) \right. \\
&\left. - Y_n^{(iteration-1)} \right]
\end{aligned}$$

Velocity of Alpha Forest ponies in the age phase of more than 16 years

$$\begin{aligned}
& \overline{VL}_n^{Iteration, Alpha} \\
&= \left[F_n^{(iteration-1), Alpha} \right. \\
&\cdot \omega_f(\text{upper bound}(ub) + \text{Random} \\
&\cdot \text{lower bound}(lb)) [Y_n^{(iteration-1)}] \\
&+ S_n^{(iteration-1), Alpha} \cdot \omega_s \left[\left(\frac{1}{NFP.P} \sum_{k=1}^{NFP.P} Y_{k=1}^{(iteration-1)} \right) \right. \\
&\left. - Y_n^{(iteration-1)} \right]
\end{aligned}$$

- i. Modernize the position of the Forest Pony
- j. Is end criterion reached? If “yes” stop
- k. Or else go to step ‘d’
- l. End

Panthera tigris corbetti optimization Algorithm

In Panthera Tigris corbetti optimization (PTC) algorithm, general behaviour of Panthera Tigris corbetti optimization [7] is imitated to formulate the algorithm. Projected PTC approach will deliver an appropriate solution to the problem by advancing from the penetrating control of its population associates in the procedure. Population entails of Panthera Tigris corbetti optimization, which pursue superior solutions by altering their positions in the examination region. Each Panthera Tigris corbetti optimization is an associate of the projected procedure’s population. Consequently, it designates a contestant solution. Its location in the examination region signifies standards for the parameters.

$$Q = \begin{bmatrix} Q_1 \\ \vdots \\ Q_i \\ \vdots \\ Q_N \end{bmatrix}_{N \times m} = \begin{bmatrix} q_{1,1} & \cdots & q_{1,m} \\ \vdots & \ddots & \vdots \\ q_{N,1} & \cdots & q_{N,m} \end{bmatrix}_{N \times m} \quad (24)$$

$Q \rightarrow$ matrix population position of Panthera Tigris Corbetti

Preliminary location of Panthera Tigris corbetti optimization in the examination region is arbitrarily defined as follows,

$$q_{i,j} = \min_j + R_{i,j} \cdot (\max_j - \min_j) \quad (25)$$

$$R_{i,j} \in [0,1]$$

$$i = 1,2,3,4,\dots,N$$

$$j = 1,2,3,4,\dots,m$$

$$\max_j \text{ and } \min_j \rightarrow$$

limits of the examination region

Computed values for the objective function is defined as,

$$B = \begin{bmatrix} B_1 \\ \vdots \\ B_i \\ \vdots \\ B_N \end{bmatrix}_{N \times 1} = \begin{bmatrix} B(Q_1) \\ \vdots \\ B(Q_i) \\ \vdots \\ B(Q_N) \end{bmatrix}_{N \times 1} \quad (26)$$

$B \rightarrow$ objective functional value

In the hunting segment Panthera Tigris corbetti optimization are commanding slayers that feedstuff by aggressive dissimilar prey. Initially population associates are rationalized grounded on mimicking the Panthera Tigris corbetti optimization stalking approach. In this stratagem, subsequent to picking the prey, the Panthera Tigris corbetti optimization assaults it and at that juncture murders the prey in a hurtling procedure. Consequently, the prey stalking segment is replicated in twofold phases.

In initial period, the location of population associates is rationalized grounded on picking and bout on the prey. This period sources abrupt and widespread vicissitudes in the location of population associates, and as a consequence, it upsurges the aptitude of the global examination and exploration of the procedure in precise glance over of the examination region. Projected prey locations for each Panthera Tigris corbetti optimization are designated from other associates of the population that have an improved objective functional rate than that associate. Locations of these projected preys are defined as,

$$A_i = \{q_k \wedge B_k < B_i\} U \{Q_{best}\} \quad (57)$$

$$k = 1, 2, 3, 4, \dots, N$$

Fresh location of the Panthera Tigris corbetti optimization while attacking the prey is defined as,

$$q_{i,j}^{C1D1} = q_{i,j} + R_{i,j} \cdot (G_i - Z_i \cdot q_{i,j}) \quad (58)$$

$G_i \rightarrow$ associate of the population

$Z_i \in \{1, 2\}$

$q_{i,j}^{C1D1} \rightarrow$ fresh location of the member

$i = 1, 2, 3, 4, \dots, N$

$j = 1, 2, 3, 4, \dots, m$

In the procedure of apprising associates, the freshly premeditated location is adequate if it advances the rate of the objective functional value.

$$Q_i = \begin{cases} q_i^{C1D1}, B_{i,j}^{C1D1} < B_i \\ Q_i, Else \end{cases} \quad (59)$$

$B_{i,j}^{C1D1} \rightarrow$ functional objective value of q_i^{C1D1}

In the subsequent period the location of the population associates is rationalized grounded on the pursuit procedure. In this procedure, the Panthera Tigris corbetti optimization alters its location in the expanse where prey confronted. This procedure upsurges the aptitude of the procedure in local examination and exploitation to grasp improved solutions.

$$q_{i,j}^{C1D2} = q_{i,j} + \frac{R_{i,j} \cdot (\max_j - \min_j)}{t} \quad (60)$$

$j = 1, 2, 3, 4, \dots, m$

$t = 1, 2, 3, 4, \dots, T$

$R_{i,j} \in [0, 1]$

$q_{i,j}^{C1D2} \rightarrow$ fresh location of the Panthera Tigris Corbetti

$$Q_i = \begin{cases} q_i^{C1D2}, B_{i,j}^{C1D2} < B_i \\ Q_i, Else \end{cases} \quad (61)$$

Few times conflict's with other animals happens while grasping the prey, at that moment Panthera tigris corbetti optimization will attack other animals which are posing as contenders to grasp the prey. Then the new location of the Panthera Tigris corbetti optimization is defined as,

$$q_i^{C2D1} = \begin{cases} q_{i,j} + R_{i,j} \cdot (q_{k,j} - Z_{i,j} \cdot q_{i,j}), B_k < B_i \\ q_{i,j} + R_{i,j} \cdot (q_{j,j} - Z_{i,j} \cdot q_{i,j}), Else \end{cases} \quad (62)$$

$k = 1, 2, 3, 4, \dots, N$

$q_{k,j} \rightarrow$ position of the contender

$q_i^{C2D1} \rightarrow$

fresh location of the Panthera Tigris Corbetti

$Z_i \in \{1, 2\}$

Freshly computed location replaces the preceding position, if the objective functional rate improves,

$$Q_i = \begin{cases} q_i^{C2D1}, B_{i,j}^{C2D1} < B_i \\ Q_i, Else \end{cases} \quad (63)$$

$B_{i,j}^{C2D1} \rightarrow$ functional objective value of q_i^{C2D1}

Location of the population associates is rationalized grounded on the replication of encounters with contenders is defined as,

$$q_{i,j}^{C2D2} = q_{i,j} + \frac{R_{i,j} \cdot (\max_j - \min_j)}{t} \quad (64)$$

$j = 1, 2, 3, 4, \dots, m$

$t = 1, 2, 3, 4, \dots, T$

$R_{i,j} \in [0, 1]$

$q_{i,j}^{C2D2} \rightarrow$ fresh location of the Panthera Tigris Corbetti

$$Q_i = \begin{cases} q_i^{C2D2}, B_{i,j}^{C2D2} < B_i \\ Q_i, Else \end{cases} \quad (65)$$

- a. Start
- b. Fix the parameters
- c. Engender the initial population
- d. $q_{i,j} = \min_j + R_{i,j} \cdot (\max_j - \min_j)$
- e. Evaluate the OBJ function
- f. For $t = 1$ to T
- g. For $i = 1$ to N
- h. Modernize the projected preys
- i. $A_i = \{q_k \wedge B_k < B_i\} U \{Q_{best}\}$
- j. Compute the new location of the associate
- k. $q_{i,j}^{C1D1} = q_{i,j} + R_{i,j} \cdot (G_i - Z_i \cdot q_{i,j})$
- l. Update the i th associate
- m. $Q_i = \begin{cases} q_i^{C1D1}, B_{i,j}^{C1D1} < B_i \\ Q_i, Else \end{cases}$

- n. Compute new location of *ith* associate
- o. $q_{i,j}^{C1D2} = q_{i,j} + \frac{R_{i,j}(\max_j - \min_j)}{t}$
- p. Update the *ith* associate
- q. $Q_i = \begin{cases} q_i^{C1D2}, B_{i,j}^{C1D2} < B_i \\ Q_i, Else \end{cases}$
- r. Panthera tigris corbetti optimization attack on contenders to grasp the prey
- s. Compute the new location of the associate
- t. $q_i^{C2D1} = \begin{cases} q_{i,j} + R_{i,j} \cdot (q_{k,j} - Z_{i,j} \cdot q_{i,j}), B_k < B_i \\ q_{i,j} + R_{i,j} \cdot (q_{j,j} - Z_{i,j} \cdot q_{i,j}), Else \end{cases}$
- u. Update the *ith* associate
- v. $Q_i = \begin{cases} q_i^{C2D1}, B_{i,j}^{C2D1} < B_i \\ Q_i, Else \end{cases}$
- w. Compute the new location of the *ith* associate
- x. $q_{i,j}^{C2D2} = q_{i,j} + \frac{R_{i,j}(\max_j - \min_j)}{t}$
- y. Update the *ith* associate
- z. $Q_i = \begin{cases} q_i^{C2D2}, B_{i,j}^{C2D2} < B_i \\ Q_i, Else \end{cases}$
- aa. $t = t + 1$
- bb. Output the best solution
- cc. End

Simulation study

Lévy based Phrynosoma douglassii inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and Panthera Tigris corbetti optimization (PTC) algorithm are validated in IEEE 118 bus system. Table 1; Figure 1 and Figure 2 shows the evaluation of results TRS (MW) - True power loss reduction, VDE (PU) - Voltage deviation

Table 1. Assessment of results (IEEE 118bus)

Method	TRS(MW)	VDE(PU)
GWO (Varan <i>et al.</i> , 2023)	128.137	1.12945
ETSO (Shaheen <i>et al.</i> , 2023)	123.511	1.21790
MPA (Shaheen <i>et al.</i> , 2023)	130.324	1.26103
PSWO (Shaheen <i>et al.</i> , 2023)	131.845	1.26654
LPD	122.789	1.10987
AWO	122.982	1.10971
FPO	121.569	1.10949
PTC	122.991	1.10992

True power loss obtained values in IEEE 118 bus system are LPD - 122. 789 (MW), AWO- 122. 982 (MW), FPO - 121. 569 (MW), PTC - 122. 991. Proposed algorithms performed well in reducing the power loss.

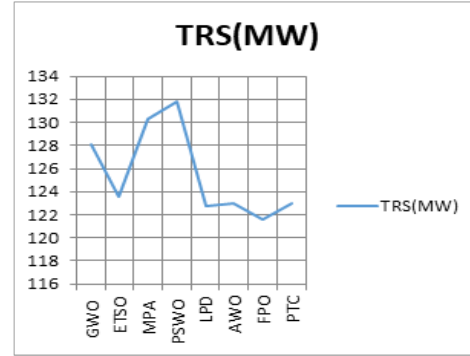


Figure 1. TRS (MW) evaluation (IEEE 118 BUS)

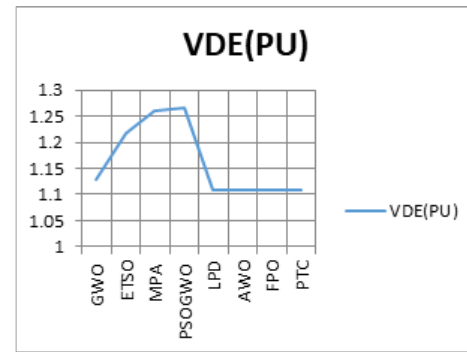


Figure 2. VDE (PU) evaluation (IEEE 118 BUS)

Lévy based Phrynosoma douglassii inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and Panthera Tigris corbetti optimization (PTC) algorithm are validated in IEEE 300 bus system. Table 2; Figure 3 and Figure 4 shows the evaluation of results

Table 2. Assessment of results (IEEE 300bus)

Method	TRS(MW)	VDE(PU)
VQI (Lima <i>et al.</i> , 2023)	418.48	1.1054
VQII (Lima <i>et al.</i> , 2023)	410.31	1.1276
MCPF (Lima <i>et al.</i> , 2023)	390.60	1.1079
OPF (Lima <i>et al.</i> , 2023)	398.02	1.0886
LPD	386.12	1.0598
AWO	386.89	1.0601
FPO	385.20	1.0583
PTC	386.96	1.0611

True power loss obtained values in IEEE 300 bus system are LPD - 386.12 (MW), AWO- 386.89 (MW), FPO - 385.20 (MW), PTC - 386.96. Proposed algorithms performed well in reducing the power loss.

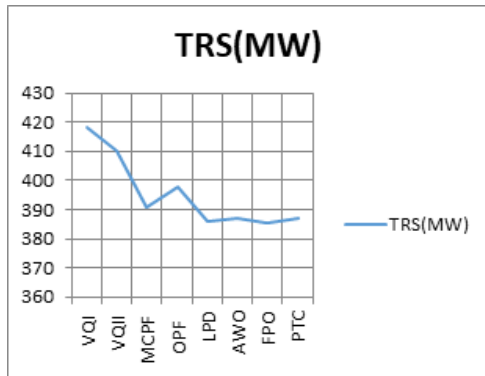


Figure 3. TRS (MW) evaluation (IEEE 300 BUS)

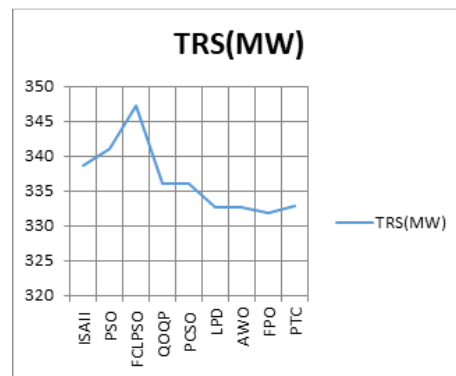


Figure 5. TRS (MW) evaluation (IEEE 354 BUS)

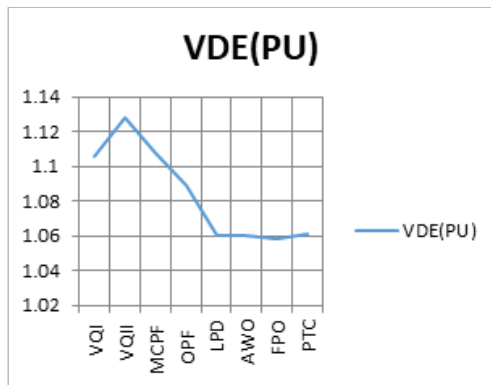


Figure 4. VDE (PU) evaluation (IEEE 300 BUS)

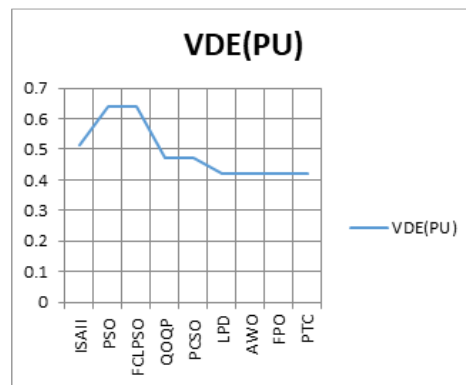


Figure 6. VDE (PU) evaluation (IEEE 334 BUS)

Lévy based Phrynosoma douglassii inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and Panthera Tigris corbetti optimization (PTC) algorithm are validated in IEEE 354 bus system. Table 3; Figure 5 and Figure 6 shows the evaluation of results

True power loss obtained values in IEEE 354 bus system are LPD - 332.567 (MW), AWO-332.601 (MW), FPO - 31.764 (MW), PTC-332.762 (MW). Proposed algorithms performed well in reducing the power loss.

Table 3. Valuation of results (IEEE 354 bus)

Method	TRS(MW)	VDE(PU)
ISAI (Khazali and Kalantar, 2011)	338.7150	0.51170
PSO (Chen <i>et al.</i> , 2016)	341.1230	0.63950
FCLPSO (Naderi <i>et al.</i> , 2017)	347.1323	0.6395
QOQP (Lenin <i>et al.</i> , 2023)	336.02	0.4719
PCSO (Lenin <i>et al.</i> , 2023)	335.96	0.4706
LPD	332.567	0.42121
AWO	332.601	0.42132
FPO	331.764	0.42121
PTC	332.762	0.42148

Time taken by the Lévy based Phrynosoma douglassii inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and Panthera Tigris corbetti optimization (PTC) algorithm is shown in Table 4 and Figure 7.

Table 4. Valuation of results (IEEE 354 bus)

Method	118 Bus T(S)	300 Bus T(S)	354 Bus T(S)
LPD	36.28	56.39	69.21
AWO	34.21	53.12	66.39
FPO	37.01	57.04	71.12
PTC	33.12	54.19	70.18

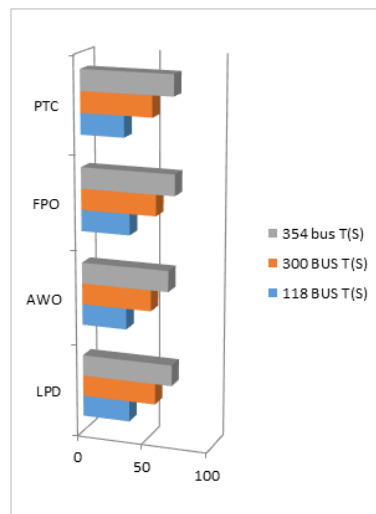


Figure 7. Time taken by LPD, AWO, FPO and PTC

Conclusion

Lévy based *Phrynosoma douglassii* inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and Panthera Tigris corbetti optimization (PTC) algorithm solved the real power loss reduction problem competently. In the Camouflage activity, the *Phrynosoma douglassii* alter its body colorant by flattering luminous to evade exposure to the predators. *Phrynosoma douglassii* alter the intensity of the colour by melanophores rendering to the conditions. The intensity of the colour varies with reference to the temperature. Blood spouting of the *Phrynosoma douglassii* is one among the defensive strategy and with reference to the position of the predator *Phrynosoma douglassii* will spout the blood from the eyes. Squirt out defense method of *Phrynosoma douglassii* define about the rapid arbitrary movement of the *Phrynosoma douglassii* from the predator to the safest environment. In AWO, procedure population is divided into set of clusters. Each cluster possesses one dominant male Alashan wapiti and associated cohorts in the rutting period. The quantity of cohorts is, based on the fitness rate of the dominant male Alashan wapiti in each cluster. Each cluster will produce novel solutions grounded on the dominant male Alashan wapiti and cohorts in the calving period. FP algorithm replicates the foraging area nearby Forest Pony with coefficient (h) and scientific execution of foraging (F). Forest Ponies from upper layer of the organized matrix are designated as Alpha cluster of Forest Ponies. Then the subsequent 20 % are in the Beta cluster.

Remaining 30 and 40 Percentage are nominated as Gamma and Delta Forest Ponies. The phases to pretend the actions of the Forest Ponies are scientifically employed to identify the velocity (motion) vector. In PTC during initial period, the location of population associates is rationalized grounded on picking and bout on the prey and it upsurges the aptitude of the global examination and exploration of the procedure in precise glance over of the examination region.

Lévy based *Phrynosoma douglassii* inspired optimization (LPD) algorithm, Alashan wapiti optimization (AWO) algorithm, Forest Pony Optimization (FPO) algorithm and Panthera Tigris corbetti optimization (PTC) algorithm are validated in IEEE 118, 300, 354 systems.

Future scope of work

This work can be extended and applied solve the large test case problems in Electrical engineering. In the area of detecting the breast cancer this algorithm can be tuned and applied.

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