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Environment Economic Order Quantity under fixed renting contract model with the application of Ranking of Neutrosophic Fuzzy Geometric Programming Technique.

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Abstract

An inventory model with pricing measures in which the cost of transportation along with its associated pollution mitigation costs, costs of insurance, costs of replacement and shadow pricing are included, which reflect the social responsibilities of the firms and these costs are considering as uncertainties.

In this paper , we have introduced ranking method of trapezoidal neutrosophic fuzzy number and solved by geometric programming technique. This approach has been illustrated with numerical example..

Keywords; *Economic order quantity, cost of insurance, cost of replacement and shadow pricing, ranking of neutrosophic trapezoidal fuzzy number, Geometric programming technique.*

I. INTRODUCTION

The concept of reality enrollment, indeterminacy participation, and deception participation factors of Neutrosophic extensive range may have awesome shape, for instance, triangular long-established, trapezoidal molded, chime formed, and so forth. We represent unmarried-esteemed trapezoidal neutrosophic numbers (SVTrNN) in which its fact enrollment, indeterminacy participation, and misrepresentation enrollment capacities can be communicated as trapezoidal fluffy numbers. Biswas et al. [22] characterised trapezoidal fluffy neutrosophic variety and their participation capacities. Till now, none has exhibited that a non-right now Neutrosophic Optimization Problem can be decreased to a Geometric Programming Problem (GPP) with posynomial phrases and comprehended by way of manner of GP method. In this manner the inspiration of the winning exam is to build up a manner to lower a non-direct Neutrosophic Problem to a regarding GPP and afterward to comprehend it by using manner of the right system counting on its level of hassle. Right now, gift another technique of positioning of trapezoidal neutrosophic fluffy range with geometric programming approach for finding economic request quanitity with estimating measures in which the cost of transportation alongside its related contamination moderation fees, charges of safety, costs of substitution.

II. STARTERS

This region present some definitions and essential thoughts diagnosed with Geometric Programming technique, Neutrosophic fluffy numbers , Trapezoidal neutrosophic fluffy quantity , Interval esteemed neutrosophic fluffy variety and its exactness paintings.

2.1Geometric programming trouble:

Base trouble: Primal Geometric Programming(PGP) trouble is

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Minimize $g_0(t) = \sum_{k=1}^{T_0} C_{0k} \prod_{j=1}^{m} t_j^{\alpha_{0kj}}$

Subject to $\sum_{k=1}^{T_0} C_{rk} \prod_{j=1}^{m} t_j^{\alpha_{rkj}} \leq 1$, (r= 1,2,…..l) , j= (1,2,3…..m) $t_j>0$

Where $C_{0k} > 0$ (k=1,2,…T_0) C_{rk} and α_{rk} are real numbers. It is constrained polynomial geometric

problem.The number of term each polynomial constrained functions varies and it is denoted by T_r

for each r= 0,1,2….. Let T= $T_0+T_1+T_2+\ldots\ldots +T_l$ be the total number of terms in the primal program.

The Degree of difficulty is (DD) = T – (m+1)

Dual Problem:

Maximize $= \prod_{r=0}^{l} \prod_{k=1}^{T^r} \left(\frac{C_{rk}}{\delta_{rk}}\right)^{\delta rk} \left(\sum_{s=1+T_{r+1}}^{T} (\delta_{rs})^{\delta rk}\right.$

Subject to $\sum_{k=1}^{T_0} \delta_{0k} = 1$ (Normality condition)

$\sum_{r=0}^{l} \sum_{k=1}^{T_r} \alpha_{rkj} \delta_{rk} = 0$ (Orthogonality conditions)

$\delta_{rk} > 0$, (Positive constant)

2.2 Neutrosophic set:

Let X be a universe set. A neutrosophic set A on X is defined as A = {TA(x), IA(x), FA(x) : x ∈ X}, where TA(x), IA(x), FA(x) : X →−]0, 1[+ represents the degree of membership, degree of indeterministic, and degree of non-membership respectively of the element x ∈ X, such that −0 ≤ TA(x) + IA(x) + FA(x) ≤ 3+for all x ∈ X.

2.3 Neutrosophic Number:

A neutrosophic set A defined on the universal set of real numbers R is said to be neutrosophic number if it has the following properties.

i) A is normal if there exists $x_0 \in R$, such that $T_A(x_0) = I (I_A(x_0) = F_A(x_0) = 0)$

ii) A is convex set for the truth function $T_A(x)$, $T_A(\mu x_1 + (1-\mu)x_2) \geq \min(T_A(x_1),T_A(x_2))$ for all $x_1, x_2 \in R$, μ[0,1]

iii) A is concave set for the indeterministic function and false function $I_A(x)$, $F_A(x)$

iv) $I_A(\mu x_1 + (1-\mu)x_2) \geq \max(T_A(x_1),T_A(x_2))$ for all $x_1, x_2 \in R$, μ[0,1] and

$T_A(\mu x_1 + (1-\mu)x_2) \geq \max(T_A(x_1),T_A(x_2))$ for all $x_1, x_2 \in R$, μ[0,1]

2.4 Trapezoidal Neutrosophic fuzzy number:

A trapezoidal neutrosophic fuzzy number A (a,b,c,d,u_A, ~~v_A,w_A~~) in R with the following truth function, indeterministic function and falsity function which is given by the following

T

$$T_{\bar{A}}(x) = \begin{cases} 0 : x < a_1 or x > a \\ \frac{(x-a)}{(b-a)} u_A : a \leq x \leq b \\ u_A : b \leq x \leq c \\ \frac{(d-x)}{(d-c)} u_A : c \leq x \leq d \\ 1, otherwise \end{cases}$$

$$I_{\bar{A}}(x) = \begin{cases} 0 : x < a \ \ or x > a \\ \frac{(b-x)}{(b-a)} v_A : a \leq x \leq b \\ v_A : b \leq x \leq c \\ \frac{(d-x)}{(d-c)} v_A : c \leq x \leq d \\ 1, otherwise \end{cases}$$

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$$F_{\bar{A}}(x) = \begin{cases} 0 : x < a \ or x > a \\ \frac{(b-x)}{(b-a)} w_A : a \le x \le b \\ w_A : b \le x \le c \\ \frac{(d-x)w_A}{(d-c)} : c \le x \le d \\ 1, otherwise \end{cases}$$

2.5 Ranking function of trapezoidal neutrosophic fuzzy number:

Let $\bar{a} = (a^l, a^{m_1}, a^{m_2}, a^{u,}, T_{\bar{a}}, I_{\bar{a}}, F_{\bar{a}})$ be a trapezoidal neutrosophic fuzzy number, where

a^l ,a^{m1} , a^{m2} ,a^u are lower bound, first and second median value and upper bound respectively. Also,

$T_{\bar{a}}, I_{\bar{a}}, F_{\bar{a}}$ are the truth , indeterminancy and falsity degree of a trapezoidal number. Then the ranking function of this trapezoidal neutrosophic fuzzy number is defined as

$$R(\bar{a}) = \frac{a^l + a^u + 2(m_1 + m_2)}{2} + (T_{\bar{a}} - I_{\bar{a}} - F_{\bar{a}})$$

III. MATHEMATICAL MODEL

3.1Assumptions

1. Limit of W devices can be placed away in the possessed distribution center.

2. In the occasion of a -distribution center framework things within the possessed stockroom are applied to fulfill

client request surely after stock within the leased stockroom is absolutely exhausted.

3. The object does not disintegrate at the same time as away and the unit keeping value consistent with unit per unit time

within the leased stockroom does exclude the leasing price and it's miles larger than the handiest within the possessed distribution center.

4. The transportation fees between stockrooms are integrated and there may be no want of more

spot advertise, because the leased distribution middle is sufficiently massive to in form the more gadgets.

5. The shops transport m gadgets to the leased distribution center beneath regular settlement and the difference

in the leasing price of M and m could no longer bring plenty of price range.

6. The road mishaps end result truly in the lack of asset.

7. Commotion prices, air infection fees and environmental exchange expenses are valued to reduce the ecological

influences and they're resolved tremendously for a solitary tour.

8. Trucks are carried out for transportation which is claimed and assured thru the shops.

3.2. Documentations

D name for steady with unit time

A consistent soliciting for price for each request

C shopping for cost in step with unit

Ho protective charge consistent with unit in keeping with unit time inside the possessed distribution middle

h1 retaining charge in step with unit steady with unit time inside the leased stockroom with a hard and fast agreement.

H2 holding fee in keeping with unit consistent with unit time in the leased stockroom with an adaptable settlement

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r1 renting fee consistent with unit regular with unit time within the leased stockroom with a fixed settlement

r2 leasing value in line with unit consistent with unit time within the leased stockroom with an adaptable agreement

M maximum intense region that can be leased inside the distribution middle with a fixed settlement

M1 least area that is qualified to be leased for an adaptable leasing rate

M2 most room that can be leased inside the stockroom with an adaptable agreement

d distance to be voyage

t transportation charge consistent with unit consistent with separation ventured out to the leased distribution center

Cp value of property damage and danger every yr

Cc fee of crash every 12 months

Ct value of licenses, costs and charges each 12 months.

Cm scientific treatment prices due to the creation of the pollutants every 12 months.

Z amount of devices had been given harmed inside the mishap

β prison rate obtained due to the occasion of the mishap

β1 noise fee from cars

β2 air infection fee from motors emanation

β3 climate alternate charge that's the resultant of the effect of pollution within the air.

IV. NUMERICAL MODEL

Fresh Model:

Enviro-EOQ model beneath constant leasing settlement version:

Think about a scenario at some point of everyday event, in which the shop is aware of the interest of his customers earlier of time, so he buys more devices, among which W gadgets can be loaded in claimed distribution middle and the rest of the gadgets are provided in the leased stockroom. The leased stockroom can match M devices. In spite of the truth that the stores shipping simply m units, the

leasing value is charged for all the M devices.

The asking for charge according to request = A

The buying charge steady with cycle = CQ

The conserving value according to cycle in the possessed stockroom is the territory of the

lower trapezium in fig.6.5.

i.e., $\frac{h_0 w}{2}[\frac{Q}{D}+\frac{Q-w}{D}]$ which can be written as $\frac{h_0}{2D}[Q^2-(Q-w)^2]$

The holding cost per cycle in the rented ware house is the area of the triangle in fig.6.5

i.e., $\frac{h_1}{2D}[Q-w]^2$

The transportation cost per cycle = mtd

The associated costs of transportation and costs of insurance per cycle = $C_t + C_p + C_c$

The medical costs related to the health deterioration due to the exposure of the pollutants from vehicles per cycle = C_M

The renting cost under fixed contract = r_1M

The replacement cost of damaged units in the accident per cycle = Cz

The judicial cost incurred due to the occurrence of the accident per cycle = β

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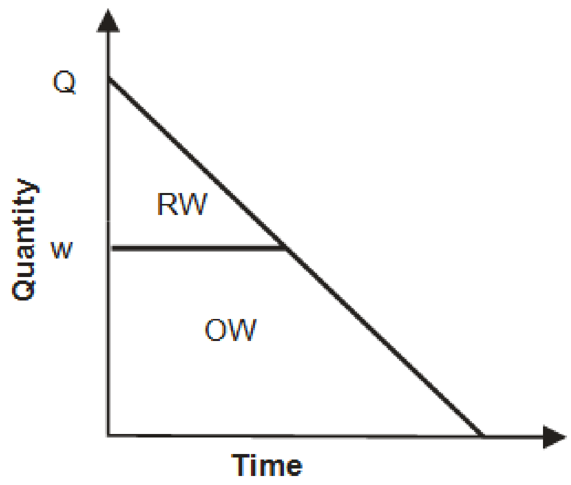
The noise cost from vehicles per cycle = $\beta_1 \frac{d}{v}$

The air pollution cost from vehicle emission per cycle = $\beta_2 \frac{d}{v}$

The climate change cost as the result of emission of pollutants from vehicle per cycle = $\beta_3 \frac{d}{v}$



The total cost per cycle

$$TC(Q)=A+CQ+\frac{h_0}{2D}[Q^2-(Q-w)^2]+\frac{h_1}{2D}[Q-w]^2$$

$$+mtd+r_1M+Cz+\beta+\beta_1\frac{d}{v}+\beta_2\frac{d}{v}+\beta_3\frac{d}{v}+C_t+C_p+C_c+C_M$$

The total inventory costs per unit time is TC(Q) = Q/T

$$=\frac{1}{T}\Big[A+CQ+\frac{h_0}{2D}[Q^2-(Q-w)^2]+\frac{h_1}{2D}[Q-w]^2$$

$$+mtd+r_1M+Cz+\beta+\beta_1\frac{d}{v}+\beta_2\frac{d}{v}+$$

$$\beta_3\frac{d}{v}+C_t+C_p+C_c+C_M\Big] \quad \text{where } T = Q/D$$

$$TC(Q)=\frac{AD}{Q}+CD+\frac{h_0}{2Q}[Q^2-(Q-w)^2]+$$

$$\frac{h_1}{2Q}[Q-w]^2+\frac{D}{Q}mtd+\frac{D}{Q}r_1M+\frac{D}{Q}Cz+\frac{D}{Q}\beta+$$

$$\frac{Dd}{Qv}(\beta_1+\beta_2+\beta_3)+\frac{D}{Q}(C_t+C_p+C_c+C_M)$$

$$=\frac{AD}{Q}+CD+\frac{h_0Q}{2}+\frac{h_1-h_0}{2Q}[Q-w]^2+\frac{D}{Q}mtd+\frac{D}{Q}$$

$$r_1M+\frac{D}{Q}Cz+\frac{D}{Q}\beta+$$

$$\frac{Dd}{Qv}(\beta_1+\beta_2+\beta_3)+\frac{D}{Q}(C_t+C_p+C_c+C_M)$$

$$TC(Q)=\frac{AD}{Q}+CD+\frac{h_1Q}{2}+\frac{h_1-h_0}{2Q}w^2+$$

$$(h_0-h_1)w+\frac{D}{Q}mtd+\frac{D}{Q}r_1M+\frac{D}{Q}Cz+\frac{D}{Q}\beta+$$

$$\frac{Dd}{Qv}(\beta_1+\beta_2+\beta_3)+\frac{D}{Q}(C_t+C_p+C_c+C_M)$$

The objective is to determine the optimal quantity. The necessary condition is $\frac{\partial(TC(Q))}{\partial Q}=0$

$$\frac{\partial(TC(Q))}{\partial Q}=$$

$$\frac{h_1}{2}-\frac{D}{Q^2}[A+mtd+r_1M+Cz+\beta+C_P+C_C+C_t+C_M]+\frac{d}{v}(\beta_1+\beta_2+\beta_3)+\frac{h_1-h_0}{2}w^2$$

The optimal order quantity is Q =

$$\sqrt{\frac{2D(A+mtd+r_1M+Cz+\beta+C_P+C_C+C_t+C_M+\frac{d}{v}(\beta_1+\beta_2+\beta_3))+(h_1-h_0)w^2}{h_1}}$$

V. SOLUTION OF THE INVENTORY MODEL BY CRISP GEOMETRIC PROGRAMMING

We solve the proposed model by applying geometric programming and the degree of difficulty is 0.

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$$TC(Q) = \frac{AD}{Q} + CD + \frac{h_1 Q}{2} + \frac{h_1 - h_0}{2Q} w^2 + (h_0 - h_1) w + \frac{D}{Q} mtd + \frac{D}{Q} r_1 M + \frac{D}{Q} Cz + \frac{D}{Q} \beta + \frac{Dd}{Qv}(\beta_1 + \beta_2 + \beta_3) + \frac{D}{Q}(C_t + C_p + C_c + C_M)$$

Max G(w) =

$$\prod_{r=1}^{n} \left[\frac{D(A+B) + \frac{(h_1 - h_0) w^2}{2}}{QW_{1r}}\right]^{W1r} \left[\frac{(h_0 - h_1) w}{W_{3r}}\right]^{W3r} \left[\frac{h_1 Q}{2W_{3r}}\right]^{W3r} \left[\frac{cD}{W_{4r}}\right]^{W4r}$$

where

$$B = mtd + r_1 M + Cz + \beta + \beta_1 \frac{d}{v} + \beta_2 \frac{d}{v} + \beta_3 \frac{d}{v} + C_t + C_p + C_c + C_M]$$

With the conditions , $w_{1r} + w_{2r} + w_{3r} + w_{4r} = 1$

$$w_{1r} + w_{4r} = 0$$

$$-w_{1r} + w_{2r} = 0$$

and $w_{1r} + w_{2r} + w_{3r} = 0$

solving these equations we get, $w_{1r} = -1$, $w_{2r} = -1$, $w_{3r} = 2$ and $w_{4r} = 0$

By applying Duffin's and Peterson's theorem ,

$$\frac{D(A+B] + \frac{(h_1 - h_0) w^2}{2}}{Q} = W_{1r}\, g(W_{1r}, W_{2r}, W_{3r}, W_{4r}) \text{------------------}(1)$$

$$h_1 Q / 2 = W_{2r}\, g(W_{1r}, W_{2r}, W_{3r}, W_{4r}) \text{--------------------}(2)$$

$$w(h_0 - h_1) = W_{3r}\, g(W_{1r}, W_{2r}, W_{3r}, W_{4r}) \text{-------------------}(3)$$

Divinding (1) by (2) , we get,

$$\frac{D(A+B] + \frac{(h_1 - h_0) w^2}{2}}{\frac{h_1}{2} Q^2} = 1$$

and

$$Q^2 = \frac{D(A+B) + (h_1 - h_0) w^2}{h_1}$$

Q =

$$\sqrt{\frac{2D(A + mtd + r_1 M + Cz + \beta + C_P + C_C + C_t + C_M + \frac{d}{v}(\beta_1 + \beta_2 + \beta_3)) + (h_1 - h_0) w^2}{h_1}}$$

VI. SOLUTION OF INVENTORY MODEL BY NEUTROSOPHIC FUZZY GEOMETRIC PROGRAMMING

$$TC(Q) = \frac{AD}{Q} + CD + \frac{h_1 Q}{2} + \frac{h_1 - h_0}{2Q} w^2 + (h_0 - h_1) w + \frac{D}{Q} mtd + \frac{D}{Q} r_1 M + \frac{D}{Q} Cz + \frac{D}{Q} \beta + \frac{Dd}{Qv}(\beta_1 + \beta_2 + \beta_3) + \frac{D}{Q}(C_t + C_p + C_c + C_M)$$

In Neutrosophic Fuzzy Model,

Let A^N = (a,b,c,d : a',b',c',d' : a",b",c",d") be a trapezoidal neutrosophic fuzzy number and RN(A) be ranking function of neutrosophic trapezoidal fuzzy number. We consider the variables D , h_1 ,r_1 ,$\beta 1$, $\beta 2$, $\beta 3$ are in neutrosophic fuzzy number.

$$TC(Q) = \frac{ARN(D)}{Q} + CRN(D) + \frac{RN(h_1) Q}{2} + \frac{RN(h_1) - h_0}{2Q} w^2 + (h_0 - RN(h_1)) w + \frac{RN(D)}{Q} [mtd + RN(r_1) M + Cz + \beta + \frac{d}{v}(RN(\beta_1) + RN(\beta_2) + RN(\beta_3)) + (C_t + C_p + C_c + C_M)]$$

$$= \frac{RN(D)}{Q} [A + mtd + RN(r_1 \; M + Cz + \beta + \frac{d}{v}(RN(\beta_1) + RN(\beta_2) + RN(\beta_3)) + (C_t + C_p + C_c + C_M)]$$

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+CRN(D)+ $\frac{RN(h_1)Q}{2} + \frac{RN(h_1) - h_0}{2Q} w^2 +$

$(h_0 - RN(h_1))w$

By applying geometric programming technique with degree of difficulty is 0. (from the primal and dual relations)

$\frac{RN(D)(A+B] + \frac{(RN(h_1) - h_0)w^2}{2}}{Q}$ = W_{1r} g(W_{1r} ,W_{2r} ,W_{3r}-,W_{4r})-------------------(1)

Where B= mtd+RN(r_1)M+ Cz+ β +RN(β_1) $\frac{d}{v}$ + $RN(\beta_2)\frac{d}{v}$ + $RN(\beta_3)\frac{d}{v}$ + C_t + C_p + C_c + C_M]

RN(h_1)Q/ 2 = W_{2r} g(W_{1r} ,W_{2r} ,W_{3r}-,W_{4r})---------------------(2)

w(h_0 –RN(h_1)) = W_{3r} g(W_{1r} ,W_{2r} ,W_{3r}-,W_{4r})--------------------(3)

Divinding (1) by (2) , we get,

$$\frac{RN(D)(A+B] + \frac{(RN(h_1) - h_0)w^2}{2}}{\frac{RN(h_1)}{2}Q^2} = 1 \quad \text{and}$$

$$Q^2 = \frac{RN(D)(A+B) + (RN(h_1) - h_0)w^2}{RN(h_1)}$$

Q=

$$\sqrt{\frac{2RN(D)(A + mtd + RN(r_1)M + Cz + \beta + C_P + C_C + C_t + C_M + \frac{d}{v}(RN(\beta_1) + RN(\beta_2) + RN(\beta_3))) + (h_1 - h_0)w^2}{RN(h_1)}}$$

VII. NUMERICAL EXAMPLE

To illustrate the result obtained in this paper, a numerical example is built up.

Consider an inventory system with the following characteristics D = 50000 units/year, A = 50$/year, M = 20000, M1 = 5000, M2 = 20000, r1 = r2 = 1.5$/unit, C = 2$/unit, z = 7500 units,

β = 75$/year, d = 20 km, v = 65 km/hr, h0 = 1$/unit, h1 = h2 = 2$/unit, β1 = 100$/year,

β2 = 125$/year, β3 = 135$/year, t = 1$/unit, m = 19000, Cp = 45$/year, Cc = 50$/year,

Ct = 70$/year, CM = 60$/year, W = 30000, S = 10,000 units.

Crisp model: The optimal order quantity is **Q =147387.38 units**.

Crisp Geometric model: The optimal order quantity is **Q_1 = 147387.4**

Ranking method neutrosophic fuzzy geometric programming model:

D = 50000 $\overline{D}$ = (49350,49450,50150,50250) (D^L, D^U) = (49400,50200) and

$(T_{\overline{D}}, I_{\overline{D}}, F_{\overline{D}})$ = (50000,49950,50000) RN(D) = 50000

h=2 $\overline{h}$ = (1.5 ,1.6, 2.1, 2.2) (h^L, h^U) = (1.55,2.15) $(T_{\overline{h}}, I_{\overline{h}}, F_{\overline{h}})$ = (2, 1.925, .2)

RN(h) = 2

r_1 = 1.5 $\overline{r_1}$ = (1 ,1.2 , 1.6,.1,8) (r_1^L, r_1^U) = (1.1, 1.7) $(T_{\overline{r_1}}, I_{\overline{r_1}}, F_{\overline{r_1}})$ = (1.5 , 1.4, 1.5) RN(r_1) = 1.6

β_1 = 100 $\overline{\beta_1}$ = (95,96,101,102) (β_1^L, β_1^U) = (95.5,101.5) $(T_{\overline{\beta_1}}, I_{\overline{\beta_1}}, F_{\overline{\beta_1}})$ = (100,100.75,100)

RN(β_1) = 100

β_2 = 125 $\overline{\beta_2}$ = (120,123,125,128) (β_2^L, β_2^U) = (121.5,126.5) $(T_{\overline{\beta 2}}, I_{\overline{\beta 2}}, F_{\overline{\beta_2}})$ = (124.5,123.5,124.5) RN(β_2) = 125.5

β_3 = 135 $\overline{\beta_3}$ = (131,132,135,136) (β_3^L, β_3^U) = (131.5,135.5) $(T_{\overline{\beta 3}}, I_{\overline{\beta 3}}, F_{\overline{\beta 3}})$ = (134,134.5,134)

RN(β_3) = 135

The optimal order quantity is = **147387.4**

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VIII. CONCLUSION

Right now, proposed the site capacity for changing over trapezoidal neutrosophic fluffy numbers to its sparkling traits via using geometric programming strategy. Consequently we presume this proposed version is straightforward and efficient.

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