St. Joseph's Journal of Humanities and Science (Volume 4 Issue 2 August 2017) 58-62

St. Joseph's Journal of Humanities and Science
ISSN: 2347-5331

http://sjctnc.edu.in/6107-2/

Application of Pentagonal Fuzzy Number in Genetic Algorithm

A. Virgin Raj[a*]

R. Praveena[b]

ABSTRACT

Genetic algorithm (GA) is a derivative free problem optimization method based on the concept of natural selection and evolutionary process. Here we have utilized this method along with crossover operators. And pentagonal fuzzy number is used in GA to analyse one pesticide from the five pesticide for a field. For this purpose we have derived results using the cost matrix of different pesticides

Keywords: Fuzzyset; Pentagonal Fuzzy Number; Genetic Algorithm, Cross over operator

1.0 INTRODUCTION

In the year of 1965 fuzzy set was introduced by L.A.Zadeh [1]. Aim of our present study is to describe the basic definition and notations of fuzzy number and also to define the pentagonal fuzzy number based on the function. Then we have utilized arithmetic operations such as addition, subtraction and multiplication of pentagonal fuzzy number. In this paper we use fuzzy number to choose the best pesticide for a field by Genetic algorithm method. Genetic algorithm is being used in various problems for representation and evaluation process. In this study GA is applied to compute the best pesticide for a field by using the method of crossover operator to find out the maximum value for evaluating.

2.0 BASIC DEFINITIONS

2.1 Definition (Fuzzy set) [1]

A fuzzy set $\tilde{A}$ in x is characterized by a membership function $_{\tilde{A}}(x)$ which associates with each point xa real number in the interval [0, 1]. A fuzzy set $\tilde{A}$ of X is defined as $\tilde{A} = \{(x, _{\tilde{A}}(x)/xX\}$, where $_{\tilde{A}}(x)$ is called the membership function which maps each element of x to value between 0and 1.

2.2 Definition (Fuzzy Number) [2]

A fuzzy set $\tilde{A}$ is defined on the interval on the universal set R, is said to be a fuzzy number if its membership function has the following characteristics.

1. $\tilde{A}$ is convex *i.e.,*)$\mu_{\tilde{A}}(\lambda x_1 + (1-\lambda)x_2) \geq \min(\mu_{\tilde{A}}(x_1), \mu_{\tilde{A}}(x_2)\ \forall \lambda \in [0, 1]\ \forall x_1, x_2 \in R$.
2. $\tilde{A}$ is normal is there exists $x_0 \in \mu_{\tilde{A}}(x_0)=1$
3. $\mu_{\tilde{A}}$ is piecewise continuous.

2.3 Definition (Triangular fuzzy number)

Triangular fuzzy number is defined as $\tilde{A} = \{a, b, c\}$ where all a, b, c are real numbers and its membership function is given below, [2]

$\mu_{\tilde{A}}(x) =$

[a]PG and Research Department of Mathematics, St.Joseph's College of Arts and Science (Autonomous), Cuddalore, Tamil Nadu, India.

[*]Email: avirginraj@gmail.com, Mobile: +91 98942 72043

[b]Research Scholar, PG and Research Department of Mathematics, St.Joseph's College of Arts and Science (Autonomous), Cuddalore, Tamil Nadu, India.

$$\mu\tilde{A}(x) = \begin{cases} \dfrac{(x-a)}{(b-a)} \text{ for } a \le x \le b \\ \dfrac{(c-x)}{(c-b)} \text{ for } b \le x \le c \end{cases}$$
otherwise

2.4 Definition 2.4 (Trapezoidal fuzzy number) [5]

A fuzzy set $\tilde{A} = (a, b, c, d)$ is said to trapezoidal fuzzy number if its membership function is given by

$$\begin{cases} 0 & \text{for } x < a \\ \dfrac{(x-a)}{(b-a)} & \text{for } a \le x \le b \\ 1 & \text{for } b \le x \le c \\ \dfrac{(d-x)}{(d-c)} & \text{for } c \le x \le d \\ 0 & \text{for c } x > d \\ \text{Where } a \le b \le c \le d. \end{cases}$$

3.0 PENTAGONAL FUZZY NUMBER

3.1 Definition (Pentagonal Fuzzy Number) [4]

A pentagonal fuzzy number of a fuzzy set $\tilde{P}$ is defined as $\tilde{P} = \{a, b, c, d, e\}$ and its membership function is given by

$$\mu_{\tilde{P}}(x) = \begin{cases} 0 & \text{for } x < a \\ \dfrac{(x-a)}{(b-a)} & \text{for } a \le x \le b \\ \dfrac{(x-b)}{(c-a)} & \text{for } b \le x \le c \\ 1, & \text{for } x = c \\ \dfrac{(d-x)}{(d-c)} & \text{for } c \le x \le\le d \\ \dfrac{(e-x)}{(e-d)} & \text{for } d \le x \le e \\ 0, & \text{for } x > e \end{cases}$$

Note: Conditions on pentagonal fuzzy number:

A pentagonal fuzzy number $\tilde{A}_p$ should satisfy the following conditions.

1. $\mu_{\tilde{A}P}(x)$ is a continuous function in the interval [0, 1].
2. $\mu_{\tilde{A}P}(x)$ is strictly increasing and continuous function on [a, b] and [b, c].
3. $\mu_{\tilde{A}}(P)$ is strictly decreasing and continuous function on (c, d] and [d, e).

4.0 ARITHMETIC OPERATION ON PENTAGONAL FUZZY NUMBER

4.1 Definition (Addition of two pentagonal fuzzy numbers)

If $\tilde{A}_P = (a_1, b_1, c_1, d_1, e_1)$ and $= (a_2, b_2, c_2, d_2, e_2)$. Then

$+ \tilde{A}_P + \tilde{O} = (a_1 + a_2, b_1 + b_2, c_1 + c_2, d_1 + d_2, e_1 + e_2)$

4.2 Definition (Subtraction of two pentagonal fuzzy numbers)

If $\tilde{A}_P = (a_1, b_1, c_1, d_1, e_1)$ and $\tilde{O}_P = (a_2, b_2, c_2, d_2, e_2)$. Then

$\tilde{A}_P - \tilde{O} = (a_1 - a_2, b_1 - b_2, c_1 - c_2, d_1 - d_2, e_1 - e_2)$

4.3 Definition (Multiplication of two pentagonal fuzzy numbers)

If $\tilde{A}_P = (a_1, b_1, c_1, d_1, e_1)$ and $\tilde{O}_P = (a_2, b_2, c_2, d_2, e_2)$. Then

$\tilde{A}_P * \tilde{O}_P = (a_1 * a_2, b_1 * b_2, c_1 * c_2, d_1 * d_2, e_1 * e_2)$.

4.4 Definition (Membership function for pentagonal fuzzy number)

Membership function of $\tilde{A}_P = (a, b, c, d, e)$ is defined as,

$$\left(\frac{a}{10}, \frac{b}{10}, \frac{c}{10}, \frac{d}{10}, \frac{e}{10}\right)$$

,, if 0≤a 0≤b ≤c 0≤d ≤e 0≤10

$$0 \le \frac{a}{10} \le \frac{b}{10} \le \frac{c}{10} \le \frac{d}{10} \le \frac{e}{10} \le 1$$

5.0 GENETIC ALGORITHM [7,9,10]

A genetic algorithm is a method for solving both constrained and non constrained and unconstrained optimization problem based on a natural selection process that mimics biological evaluation. The algorithm repeatedly modifies a population of individual solution [7].

5.1 INTRODUCTION TO CROSSOVER OPERATOR

The crossover operator is analogous to reproduction and biological crossover. In this more than one parent is selected and one or more off-spring are produced using genetic material of the parent. Crossover is usually applied in a genetic algorithm with a high probability. [6]

5.2 OPERATIONS USED ON GENETIC ALGORITHM

i) Genetic coding

ii) Fitness function

iii) Selection process

iv) Crossover operator

5.3 TYPES OF CROSSOVER OPERATOR

There are three types of crossover for using in genetic algorithm. They are

i) One-point crossover.

ii) Multi-point crossover.

iii) Uniform crossover.

5.4 ONE-POINT CROSSOVER

In this one-point crossover, a random crossover point is selected and the tails of its two parents are swapped to get new off-spring[8].

5.4.1 Example

{0, 1, 2, 3, 4, 5, 6, 7}

{7, 6, 3, 1, 4, 2, 8, 5}

Suppose we choose k=5 then we have

{0, 1, 2, 3, **4, 2, 8, 5**}

{7, 6, 3, 1, **4, 5, 6, 7**}

6.0 PROCEDURE

Step 1: First randomly select two fields F_1 and F_2.

Step 2: Next select another two fields F_3 and F_4.

Step 3: Convert all the elements fuzzy number into its membership function.

Step 4: Set the pentagonal fuzzy number in weights of the fields.

Step 5: Take the values from the field

Step 6: Calculate the cost matrix m=$_i$ y_i

Step 7: Find the maximum values. Then select the best.

Step 8: Do the crossover operation and find maximum values of the field.

6.1 NUMERICAL EXAMPLE

Suppose there are four types of fields F_1, F_2, F_3 and F_4. Let the possible attributes to above fields w= (a, b, c, d, e) as universal set. Where a, b, c, d, e represents the five types of seeds like (Paddy, Black gram, ground nut, Seasame, corn) respectively. Compute the pentagonal fuzzy number in four fields F_1,F_2, F_3 and F_4 by considering completing work.

Step 1: F_1= (30, 8, 20, 5, 6) ; F_2=(35, 9, 18, 3, 7)

Step 2: F_3= (28, 6, 22, 6, 5) ; F_4= (31, 5, 23, 6,7)

Step 3: Convert the pentagonal fuzzy number into membership function.

F_1= (3.0, 0.9, 2.0, 0.5, 0.6); F_2= (3.5, 0.9, 1.8, 0.3, 0.7)

F_3= (2.8, 0.6, 2.2, 0.6, 0.5); F_4= (3.1, 0.5,2.3,0.6.0.7)

Step 4: Consider the above fuzzy number is fuzzy weights f_{ij}

f_{11}=0.7, f_{12}=0.8, f_{13}=0.9, f_{14}= 0.75, f_{15}= 0.85

f_{21}=0.7, f_{22}=0.8, f_{23}=0.9, f_{24}= 0.75, f_{25}= 0.85

f_{31}=0.7, f_{32}=0.8, f_{33}=0.9, f_{34}= 0.75, f_{35}= 0.85

f_{41}=0.7, f_{42}=0.8, f_{43}=0.9, f_{44}= 0.75, f_{45}= 0.85

Step 5: calculate the cost matrix f= $_i$ y_i

Table-1: Calculate the Cost Matrix for Field 1

N	3.0	0.8	2.0	0.5	0.6
0.7	2.1	0.56	1.4	0.35	0.42
0.8	2.4	0.64	1.6	0.4	0.48

0.9	2.7	0.72	1.8	0.45	0.54
0.75	2.25	0.6	1.5	0.3	0.45
0.85	2.5	0.68	1.7	0.42	0.51

Max = {2.7, 0.72, 1.8, 0.45, 0.54}

Table-2: Calculate the Cost Matrix for Field 2

N	3.5	0.9	1.8	0.3	0.7
0.7	2.45	0.63	1.26	0.21	0.49
0.8	2.8	0.72	1.44	0.24	0.56
0.9	3.15	0.81	1.62	0.27	0.63
0.75	2.62	0.67	1.35	0.22	0.52
0.85	2.97	0.76	1.53	0.25	0.59

Max = {3.15, 0.81, 1.62, 0.27, 0.63}

Table-3: Calculate the Cost Matrix for Field 3

N	2.8	0.6	2.2	0.6	0.5
0.7	1.96	0.42	1.54	0.42	0.35
0.8	2.24	0.48	1.76	0.48	0.4
0.9	**2.52**	**0.54**	**1.98**	**0.54**	**0.45**
0.75	2.1	0.45	1.65	0.45	0.37
0.85	2.38	0.51	1.87	0.51	0.42

Max = {2.52, 0.54, 1.98, 0.54, 0.45}

Table-4: Calculate the Cost Matrix for Field 4

N	3.1	0.5	2.3	0.6	0.7
0.7	2.17	0.35	1.61	0.42	0.49
0.8	2.48	0.4	1.84	0.48	0.56
0.9	**2.79**	**0.45**	**2.07**	**0.54**	**0.63**
0.75	2.32	0.37	1.72	0.45	0.52
0.85	2.63	0.42	1.95	0.51	0.59

Max = {2.79, 0.45, 2.07, 0.54, 0.63}

Step 6: Therefore among the five pesticides it is found that urea is the best pesticide.

Step 7: Select the two fields F_1 and F_2 then do the crossover operation.

F_1= {2.7, 0.72, 1.8, 0.45, 0.54}

F_2= {3.15, 0.81, 1.62, 0.27, 0.63}

Randomly choose an integer k in {0,1,…5}. Suppose k=1 then form F_1^1 and $F_2^{1.}$

F_1^1= {3.15, 0.81, 1.62, 0.27, 0.63}

F_2^1= {2.7, 0.72, 1.8, 0.45, 0.54}

Suppose k= 3

F_1^1= {3.15, 0.81, 1.8, 0.45, 0.54}

F_2^1= {2.7, 0.72, 1.62, 0.27, 0.63}

Suppose k= 5

F_1^1= {3.15, 0.81, 1.8, 0.45, 0.63}

F_2^1= {2.7, 0.72, 1.62, 0.27, 0.54}

Therefore the max value is {3.15, 0.81, 1.8, 0.45, 0.63} ……………………(1)

Next we choose two fields F_3 and F_4 and again do the crossover operation.

F_3= {2.52, 0.54, 1.98, 0.54, 0.45}

F_4= {2.79, 0.45, 2.07, 0.54, 0.63}

Suppose k=1

F_3^1= {2.79, 0.45, 2.07, 0.54, 0.63}

F_4^1= {2.52, 0.54, 1.98, 0.54, 0.45}

Suppose k=2

F_3^1= {2.79, 0.54, 1.98, 0.54, 0.45}

F_4^1= {2.52, 0.45, 2.07, 0.54, 0.63}

Suppose k=3

F_3^1= {2.79, 0.54, 2.07, 0.54, 0.63}

F_4^1= {2.52, 0.45, 1.98, 0.54, 0.45}

Max value is {2.79, 0.54, 2.07, 0.54, 0.63} ……………………(2)

Comparing (1) and (2)

{3.15, 0.81, 1.8, 0.45, 0.63}

{2.79, 0.54, 2.07, 0.54, 0.63}

Suppose k=3

{3.15, 0.81, 2.07, 0.54, 0.63}

{2.79, 0.54, 1.8, 0.45, 0.63}

Max value is {3.15, 0.81, 2.07, 0.54, 0.63}

Finally we get the maximum

7.0 CONCLUSION

We have concluded that pentagonal fuzzy number is applied to solve the agriculture problem by using Genetic algorithm. The result of the numerical example shows the best solution for field. In the numerical example we have computed the efficient pesticide. Then we took the crossover operation and compared with four fields to find out the maximum values. From those five pesticides we found that one efficient pesticide that will be commonly used in the field of agriculture.

REFERENCES

1. L.A zadeh 'fuzzy sets' information and control (1965), 338-353.
2. George A. glir and Boyan, fuzzy set and fuzzy logic theory and applications, Prentice-Hall Inc, (1995).
3. G. facchinetti and N. pacchiaroti, evaluation of fuzzy quantities,fuzzy sets and fuzzy systems 157(006), 892-903.
4. T.Pathinathan and K.ponnivalavan ,pentagonal fuzzy number, international journal of computing algorithm, 03 (2014).
5. D.dubois and H.prade, operations of fuzzy numbers on fuzzy numbers, international journal of system science, 9, 613-626.
6. M.A.Ahmed, I. Hermade-crenetic Algorithm based multiple paths test data generator", computer& operation research.
7. M.Herrim "genetic Algorithm", http://seminar projects.com/attachment. php? Aid =40499.
8. T.Hussain, "methods for combining Neural networks and Genetic algorithm", queem university, 1997.
9. A.phogat, "Travelling salesman problem using genetic algorithm", IMS Engineering college, NH-24, Adhyatmic Nagar, dasna-ghaziabad.
10. D.whitly, "genetic algorithm and neural networks", book title, "Genetic algorithm in engineering and computer science", publisher "john wily,pp 191-201.