

## Selection Technique of Genetic Algorithm in Turing Machine

<sup>1</sup>Eman Ali Hussain and <sup>2</sup>Yahya Mourad Abdul Abbass

<sup>1</sup>Department of Mathematics, College of Science, Al-Mustansiriya University, Baghdad, Iraq

<sup>2</sup>Ministry of Education, Educational Directorate Babylon, Baghdad, Iraq

emansultan@yahoo.com, yihiamor@yahoo.com

---

**Abstract:** Genetic algorithms are optimization methods using to solve a problem based on the model of natural evolution which has number of steps like initialization, selection, crossover and mutation. The selection is one important operator in these algorithms. Selection is the process of finding out the best individuals for mating process, so that, the offspring are produced child than the previous population in this study, we introduced a technique selection of Genetic algorithms in turing machine that advantages to introduce of the candidate solutions and the Genetic diversity. The proposed technique that does not dependence on Grammatical Evolution (GE) to find the candidate solutions also the speed of work and accuracy and storage capacity less.

**Key words:** Genetic algorithms, grammatical evolution, selection method, turing machine, differential equation, proposed

---

### INTRODUCTION

Genetic algorithms was originally developed by Holland (1975). The theory of Genetic Algorithms (GAs) is a problem solving method that uses the concepts of Mendelian genetics and Darwinian evolution as the model of problem solving (Goldberg, 1989; Michalewicz., 2007). Holland's GA is a method for moving from one population of "chromosomes" to a new population by using the genetics operators like crossover, mutation and selection, chromosome contains a group of numbers that present as a candidate solution (Kumar *et al.*, 2013). Selection is the stage of a Genetic algorithm in which from the search space selected a population of chromosomes, almost randomly, present as candidate solutions to optimize the problem (Michalewicz, 2007). The fitness function is used to evaluate the chromosomes in this population. By used selection operator to select chromosomes to be parents in the next generation, the next generation is finally formed by an alternative mechanism between parents and their off spring (DeJong, 2006). The selection operator is aimed to improve the best characteristics of good candidate solutions throughout generations which should converge to an acceptable solution of the optimization problem (Goldberg, 1989). Selection operator is the important parameter that may affect the performance of a GA (Back and Hoffmeister, 1991). The main objective of selection strategy is "the better is an individual the higher is its chance of being parent". The process that

determines which solutions are to be preserved and allowed to reproduce and which ones deserve to die out (Mitchell, 1998). The main objective of the selection operator is to emphasize the good solutions and eliminate the bad solutions in a population while keeping the population size constant

**Some types of selection techniques in GA:** The types of selection techniques in GA consisting of six methods often used in Genetic algorithms, the most commonly used selection methods include roulette wheel selection, rank selection, tournament selection, Boltzmann selection, stochastic universal sampling and truncation selection. (Jebari and Madiafi, 2013). We will talk about roulette wheel selection briefly.

**Roulette wheel selection:** Roulette wheel also known as fitness proportionate selection is the simplest traditional GA selection techniques. In this technique placed all the chromosomes in the population on the roulette wheel according to their fitness value. Each individual is given a segment of roulette wheel whose size is proportional to the value of the fitness of the individual (Razali and Geraghty, 2011). If the fitness value is bigger impels the segment larger, then the virtual roulette wheel spinned. If the roulette wheel stops, the individual corresponding to the segment then are selected. Repeated the process until the wanted number of individuals is selected. The individuals have higher fitness have more probability of selection. There is no guarantee that good individuals will

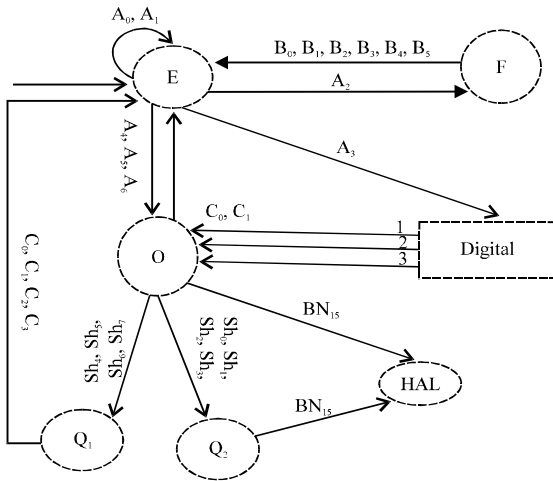


Fig. 1: Turing machine of grammatical evolution

find their way (Kumar and Jyotishree, 2012) into next generation. In roulette wheel, individuals are selected with a probability that is directly proportional to their fitness values. The probabilities of selecting a parent can be happen on.

**Selection technique of GA in TM:** The representation of the function  $f(x)$  in TM (Turing Machine) by using design of Grammatical Evolution (GE), the (Fig. 1 and 2) is design of TMGE (Turing Machine for Grammatical Evolution) with Table 1 for describe symbols, the sequence of symbols corresponding to the function  $f(x)$ , the following definition of transformation from sequence of the production rules to the function  $f(x)$ . This corresponding of the sequence 04001010044320315345003324F and function:

$$x + \sin(x+1) - \frac{(x^2+1)}{x} + 3x$$

where,  $N_r = 4$ ,  $N_{pm} = 5$  and  $N_{op} = 8$ , table of character using in graph of turing machine where (E) is Expression, (O) is Operation, (F) is Function and (D) is Digital number.

**Definition (4.1):** TS is transformation from a space of sequence of production rules  $p = \{p_1, p_2, \dots\}$ , applied in one of TM set into the set functions  $F = \{f_1, f_2, \dots\}$  define by TS:  $P \times TM \rightarrow F$

A <sub>0</sub>	A <sub>4</sub>	C <sub>4</sub>	A <sub>0</sub>	A <sub>3</sub>	D <sub>2</sub>	C <sub>0</sub>	A <sub>2</sub>	B <sub>0</sub>	A <sub>4</sub>	Sh <sub>1</sub>	BN <sub>15</sub>
0	4	4	0	3	2	0	2	0	4	1	15
0	4	4	0	3	2	0	2	0	4	1	F

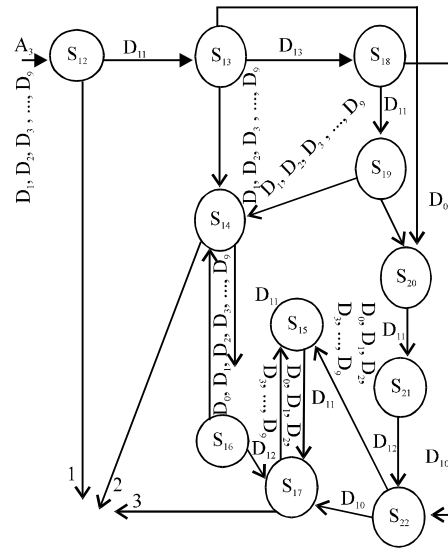


Fig. 2: Turing machine of digital number

**Definition (4.2):** If the function  $f(x)$  in  $R^2$ , then denoted for:

- The Number of terms in  $f(x)$  by  $N_t$
- The Number of pluses and minus by  $N_{pm}$
- The number of operation in function by  $N_{op}$
- The number of pluses, minus, multiplication, division and power in function by  $N_0-N_4$  with respectively

$$N_{pm} = N_0 + N_1$$

$$N_{op} = \sum_{i=0}^4 N_i$$

$$\sum = \{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15\}$$

Corresponding to the set of hexadecimal digits:

$$\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F\}$$

**Example (4.1):** From Fig. 1 and 2 and Table 1 the sequence  $A_0, A_4, C_4, A_0, A_3, D_2, C_0, A_2, B_0, A_4, Sh_1, BN_{15}$ , this corresponding of the sequence 04403202041F and function  $x^2 + \sin(x)$  then by the bellow follow table:

Table 1: Production rules and symbols

Samples	Definition
A <sub>0</sub>	0/EOE/N
A <sub>1</sub>	1/(E)/R
A <sub>2</sub>	2/F(E)/N
A <sub>3</sub>	3/D/N
A <sub>4</sub>	4/x/R
A <sub>5</sub>	5/y/R
A <sub>6</sub>	6/z/R
B <sub>0</sub>	0/sin/R <sub>4</sub>
B <sub>1</sub>	1/cos/R <sub>4</sub>
B <sub>2</sub>	2/exp/R <sub>4</sub>
B <sub>3</sub>	3/log/R <sub>4</sub>
B <sub>4</sub>	4/sqrt/ R <sub>5</sub>
B <sub>5</sub>	5/ln/ R <sub>3</sub>
C <sub>0</sub>	0/+R
C <sub>1</sub>	1/-R
C <sub>2</sub>	2*/R
C <sub>3</sub>	3/=R
C <sub>4</sub>	4/^R
D <sub>0</sub>	0/0/R
D <sub>1</sub>	1/1/R
D <sub>2</sub>	2/2/R
D <sub>3</sub>	3/3/R
D <sub>4</sub>	4/4/R
D <sub>5</sub>	5/5/R
D <sub>6</sub>	6/6/R
D <sub>7</sub>	7/7/R
D <sub>8</sub>	8/8/R
D <sub>9</sub>	9/9/R
D <sub>10</sub>	10/D/N
D <sub>11</sub>	11/DD/N
D <sub>12</sub>	12/. /R
D <sub>13</sub>	13/-/R
D <sub>14</sub>	14/ π /R
SH <sub>0</sub>	0/N
SH <sub>1</sub>	1/R
SH <sub>2</sub>	2/R2
SH <sub>3</sub>	3/R3
SH <sub>4</sub>	4/N
SH <sub>5</sub>	5/R
SH <sub>6</sub>	6/R2
SH <sub>7</sub>	7/R3
BN <sub>15</sub>	15/BN

Where:

$$N_t = 2, N_{pm} = 1 \text{ and } N_{op} = 2$$

**Example (4.2):** From Fig. 1 and 2 Table 1, the sequence A<sub>2</sub> B<sub>0</sub>, A<sub>0</sub>, A<sub>4</sub>, C<sub>0</sub>, A<sub>3</sub>, D<sub>3</sub>, BN<sub>15</sub>, this corresponding of the sequence 2004033F and function sin (x+3) then by Table 2:

A <sub>0</sub>	A <sub>1</sub>	A <sub>0</sub>	A <sub>3</sub>	C <sub>0</sub>	A <sub>5</sub>	SH <sub>5</sub>	C <sub>4</sub>	A <sub>3</sub>	D <sub>3</sub>	BN <sub>15</sub>
0	1	0	4	0	5	5	4	3	3	15
0	1	0	4	0	5	5	4	3	3	F

This corresponding of the sequence.  
003B25AC1A1244033103320440322003220403B11F

Table 2: Calculation the number of terms

Symbols of expression	Expression	Unknown operation (U <sub>n</sub> )	No. of terms (N <sub>t</sub> )	Trace of operation (T <sub>op</sub> )
A <sub>0</sub>	EOE	1	1	0
A <sub>3</sub> , D <sub>2</sub>	2OE	1	1	0
C <sub>2</sub>	2*E	0	1	0
A <sub>0</sub> , A <sub>4</sub>	xOE	1	1	0
C <sub>4</sub>	X <sup>E</sup>	0	1	0
A <sub>0</sub> , A <sub>3</sub> , D <sub>2</sub>	X <sup>2OE</sup>	1	1	0
C <sub>1</sub>	X <sup>2</sup> -E	0	2	0
A <sub>0</sub> , A <sub>3</sub> , D <sub>3</sub>	3OE	1	2	0
C <sub>2</sub>	3*E	0	2	0
A <sub>0</sub> , A <sub>2</sub> , B <sub>0</sub>	Sin(E)OE	1	2	1
A <sub>0</sub> , A <sub>4</sub>	Sin(xOE)OE	2	2	1
C <sub>0</sub>	Sin(x+E)OE	1	2	1
A <sub>0</sub> , A <sub>3</sub> , D <sub>3</sub>	Sin(x+3OE)OE	2	2	1
C <sub>2</sub>	Sin(x+3*E)OE	1	2	1
A <sub>5</sub> , SH <sub>1</sub>	Sin(x+3y)OE	1	2	0
C <sub>0</sub>	Sin(x+3y)+E	0	3	0
A <sub>0</sub>	+EOE	1	3	0
A <sub>3</sub> , D <sub>2</sub>	2OE	1	3	0
C <sub>2</sub>	2*E	0	3	0
A <sub>4</sub>	2*E	0	3	0
BN <sub>15</sub>	2*x	0	3	0

A <sub>2</sub>	B <sub>0</sub>	A <sub>0</sub>	A <sub>4</sub>	C <sub>0</sub>	A <sub>3</sub>	D <sub>3</sub>	BN <sub>15</sub>
2	0	0	4	0	3	3	15
2	0	0	4	0	3	3	F

Where:

$$N_t = N_{pm} = N_{op} = 1$$

**Example (4.3):** From Fig. 1 and 2, Table 1, the sequence A<sub>0</sub> A<sub>1</sub>, A<sub>0</sub>, A<sub>4</sub>, C<sub>0</sub>, A<sub>5</sub>, SH<sub>5</sub>, C<sub>4</sub>, A<sub>3</sub>, D<sub>3</sub>, NB<sub>15</sub>, this corresponding of the sequence 0104055433F and function (x+y)<sup>3</sup> then by the Table 2: Where:

$$N_t = N_{pm} = N_{op} = 1$$

**Example (4.4):** From Fig. 1 and 2 Table 1, the sequence:

A<sub>0</sub>, A<sub>0</sub>, A<sub>3</sub>, D<sub>11</sub>, D<sub>2</sub>, D<sub>5</sub>, D<sub>10</sub>, D<sub>12</sub>, D<sub>1</sub>,  
 D<sub>10</sub>, D<sub>1</sub>, C<sub>2</sub>, A<sub>4</sub>, C<sub>4</sub>, A<sub>0</sub>, A<sub>3</sub>, D<sub>3</sub>,  
 C<sub>1</sub>, A<sub>0</sub>, A<sub>3</sub>, D<sub>3</sub>, C<sub>2</sub>, A<sub>0</sub>, A<sub>4</sub>, C<sub>4</sub>, A<sub>0</sub>, A<sub>3</sub>, D<sub>2</sub>,  
 C<sub>0</sub>, A<sub>0</sub>, A<sub>3</sub>, D<sub>2</sub>, C<sub>2</sub>, A<sub>0</sub>, A<sub>4</sub>,  
 C<sub>0</sub>, A<sub>3</sub>, D<sub>11</sub>, D<sub>1</sub>, D<sub>1</sub>, BN<sub>15</sub>

And function:

$$25.11x^3 - 3x^2 + 2x + 11$$



Table 3: Production rules and symbols for simple term

Sample	Definition	No.	Sample	Definition
A <sub>0</sub>	0/EOE/N	16	D <sub>2</sub>	2/2/R
A <sub>2</sub>	2/F(E)/N	17	D <sub>3</sub>	3/3/R
A <sub>3</sub>	3/D/N	18	D <sub>4</sub>	4/4/R
A <sub>4</sub>	4/x/R	19	D <sub>5</sub>	5/5/R
B <sub>0</sub>	0/sin/R <sub>4</sub>	20	D <sub>6</sub>	6/6/R
B <sub>1</sub>	1/cos/R <sub>4</sub>	21	D <sub>7</sub>	7/7/R
B <sub>2</sub>	2/exp/R <sub>4</sub>	22	D <sub>8</sub>	8/8/R
B <sub>3</sub>	3/log/R <sub>4</sub>	23	D <sub>9</sub>	9/9/R
B <sub>4</sub>	4/sqrt/R <sub>5</sub>	24	D <sub>10</sub>	10/D/N
B <sub>5</sub>	5/ln/R <sub>5</sub>	25	D <sub>11</sub>	11/DD/N
C <sub>0</sub>	0/+R	26	D <sub>12</sub>	12/-R
C <sub>1</sub>	1/-R	27	D <sub>13</sub>	13/-/R
C <sub>2</sub>	2/*R	28	D <sub>14</sub>	14/δ/R
C <sub>4</sub>	4/^R	29	SH <sub>1</sub>	1/R
D <sub>0</sub>	0/0/R	30	BN15	15/B/N
D <sub>1</sub>	1/1/R			

Table 4: Number of terms in production

Type	T1	T2	...	T <sub>r</sub>
Frequency appear	n <sub>1</sub>	n <sub>2</sub>	...	n <sub>r</sub>

**Standard simple terms**

The simple term is one of the following types: Standard Function (SF): A f(bx) where f(x) ∈ {sin(x), cos(x), e<sup>x</sup>, log(x), sqrt(x), ln(x)} and a, b ∈ R such as 2.1 sin(4x) or -4.1 e<sup>(5x)</sup>.

**Constant Function (CF):** The C where, c is a constant c ∈ R, such as 45.67676 or -4532.87.

**Power Function (PF):** A x<sup>n</sup> where a ∈ R and n ∈ R such as.

**Line Function (LF):** A x<sup>n</sup> where, a ∈ R such as 6.1x, x, -3x Fig. 2 and 3 to create random function of above types SF, CF, PF and LF from two Fig. 2 and 3 of TM, the size of the set of States S is 17 states.

Where:

$$S = \{S_0, S_1 \& S_{11}, S_{12}, S_{13} \& S_{16}, HALT\}, |S| = 17$$

And the number of elements in Γ is 27:

$$\Gamma = \{A_0, A_2, A_4, B_0, \& B_5, D_0, D_1, \dots, D_9, D_{11}, D_{12}, D_{14}, SH_1, BN_0\} |S| = 27$$

**Selection random simple term:** To select a random term from Fig. 3 and 2 by generate random digit in States S<sub>2</sub>, S<sub>7</sub> and block of states of digits denoted by digital (1-3).

In block of digital (1) in Fig. 3, there are two paths, one for constant function ( forward BN<sub>15</sub>) and other C<sub>2</sub> (have three paths in State S<sub>2</sub>), then there two paths k = 15 for BN<sub>15</sub> and k = 2 for C<sub>2</sub>, if r random between 0 and 1, then generate random k where (Eq. 1):

$$k = 28 - 13 \lceil r + 0.75 \rceil, 0 < r < 1 \tag{1}$$

In state S<sub>2</sub> of Fig. 3, the random number 0, 2 and 4 if r random between 0 and 1, then generate random A<sub>k</sub> where (Eq. 2):

$$k = 2 \lceil 3r \rceil - 2, 0 < r < 1 \tag{2}$$

In state S<sub>7</sub> of Fig. 3, the random is 0, 1, 2, 3, 4 and 5, if r random between 0 and 1, then generate random B<sub>k</sub> where (Eq. 3):

$$k = \lfloor 6r \rfloor, 0 < r < 1 \tag{3}$$

$$\begin{aligned} \min \beta, & \quad \beta \geq 0 \\ \text{Such that} & \quad 10^\beta D_p - \lfloor 10^\beta D_p \rfloor = 0 \end{aligned}$$

**How partition a random digit:** To partition a random digit x in digital block of Fig. 3 where x is depended on the size of number if x digit belong the interval [a, b] where x have integer part I<sub>p</sub>(x) and decimal part D<sub>p</sub>(x),

**Integer part:** To calculate the sequence of α decimal places of integer part of x is I<sub>p</sub> where:

$$I_p(x) = \lfloor |x| \rfloor$$

**Example(4.8):** If x = 528.25, then I<sub>p</sub>(x) = ⌊528.25⌋ = 528. The number of digit in I<sub>p</sub> is α where, (Eq. 4):

$$\alpha = \begin{cases} \lceil \log_{10}(I_p) \rceil & x \neq 0 \\ 1 & x = 0 \end{cases} \tag{4}$$

From above example α = ⌈log<sub>10</sub>(528)⌉ = 3. The decimal places of I<sub>p</sub> from left to right are :

$$I_p = \sum_{k=1}^{\alpha} I_k 10^{k-1}$$

Where:

$$\begin{aligned} I_k &= \lfloor 10^{1-k} X_{\alpha-k+1} \rfloor, k = \alpha, \alpha-1, \dots, 2, 1 \\ x_{k+1} &= x_k - 10^{\alpha-k} I_{\alpha-k+1}, x_1 = I_p \end{aligned}$$

From above example:

$$\begin{aligned} x_1 &= 528, I_3 = \lfloor 10^{1-3} x_3 \rfloor = 5 \\ x_2 &= x_1 - 10^2 I_3 = 28, I_2 = \lfloor 10^{1-2} x_2 \rfloor = 2 \\ x_3 &= x_2 - 10^1 I_2 = 8, I_1 = \lfloor 10^{1-1} x_1 \rfloor = 8 \end{aligned}$$

**Example (4.9):** If x = -368 < 0, then I<sub>p</sub> = 368 and α = ⌈log<sub>10</sub>(368)⌉ = 3, then I<sub>1</sub> = 8, I<sub>2</sub> = 6, I<sub>3</sub> = 3.

**Decimal part:** The decimal part of the number x is:

$$D_p(x) = |x - \lfloor x \rfloor|$$

From above example, since,  $x = 528.25$ , then  $D_p(x) = 1528.25 - \lfloor 528.25 \rfloor = 0.25$ . The number of digit in decimal  $D_p$  is  $\beta \geq 0$  where  $\beta$  is minimum value of. From above example  $D_p = 0.25$ , then  $10^2 \cdot 0.25 - \lfloor 10^2 \times 0.25 \rfloor = 0 \beta = 2$ . Also, for example,  $x = 12.0254$ , then  $I_p = 12$ ,  $D_p = 0.0254$ ,  $\alpha = 2$  and  $\beta = 4$ . The places decimal parts of  $D_p$  from left to right are:

$$D_p = \sum_{k=1}^{\beta} d_k \times 10^{-k}$$

$$d_k = \lfloor 10x_k \rfloor, k = 1, 2, \dots, \beta$$

$$x_k = 10x_{k-1} - d_{k-1}$$

Where:

$$x_1 = D_p$$

From above example:

$$x_1 = 0.25, d_1 = \lfloor 10x_1 \rfloor = 2$$

$$x_2 = x_1 - 10^{-1} d_1 = 0.05, d_2 = \lfloor 10^2 x_1 \rfloor = 5$$

**Algorithm 2; The random sequence production:**

```

Input : random number x
Output: sequence of production
1- I = 0, j = 0, k = -1, h = 1, P = φ
2- Calculate Ip(x), Dp(x), α and β from (4.1), (4.2) and (4.3)
3- Calculate I1, I2, ..., Iα, d1, d2, ..., dβ
4- if x > 0
    if α = 1 and β = 0
        P = P || D1
        goto finsh
    end
    P = P || D11
    I = i + 1
    P = P || Di
Int1: while i != α - 1
        P = P || D11
        i = i + 1
        P = P || Di
    end
    if β = 0
        i = i + 1
        P = P || Di
        goto finsh
    else
        P = P || D12
Dec1: while j! = β - 1
        j = j + 1
        P = P || Ddj
        P = P || D11
    end
    j = j + 1
    P = P || Ddj
    goto finsh
end
end
end
    
```

**RESULTS AND DISCUSSION**

**Generate sequence of I<sub>0</sub>, I<sub>1</sub>, I<sub>2</sub>, ..., I<sub>α</sub> and d<sub>1</sub>, d<sub>2</sub>, ..., d<sub>β</sub>:**  
 From Fig. 2 for every number  $x \in \mathbb{R}$ , there are sequence  $I_0, I_1, I_2, \dots, I_\alpha, d_1, d_2, \dots, d_\beta$  corresponding to production

sequence  $D_{11}, D_{12}, \dots, D_{1\beta}$  for example 83.52 where  $I_1 = 3, I_2 = 8, d_1 = 5$  and  $d_2 = 2$ , corresponding  $D_{11}, D_{12}, D_{13}, D_{14}, D_{15}, D_{16}, D_{17}, D_{18}, D_{19}, D_{20}$  or B8B3BC5B2, the following algorithm to find the sequence random number.

**The chromosome for t-terms:** The chromosome is a sequence formed from the numbers  $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15\}$  corresponding  $\{0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F\}$ . For example, by used Fig. 3 and 2 and Table 2, then the sequence of 03B32AC1204432F is a corresponding to one term  $2.1x^2$ , of one term. The chromosome of t-terms ( $t = 3$ ) separated by character F, for example,  $\sin(x) + x^2 + 2.1x^3$  is 03322031241F031204432F03B2BC2204433F.

**Selection algorithm for TM:** If is a fitness chromosomes (t-terms) function of Table 5:

**Algorithm 3: Fitness chromosnous**

```

5- if x < 1 and x > 0
Dec2: P = P | D0 | D11 | D12
    if j = β - 1
        j = j + 1
        P = P | D10 | Ddj
        goto finsh
    end
    goto Dec1
end
if x < 0
P = P | D13 | D11
6- if x < -1 and x > 0 and α = 1
    goto Dec2
else
    i = i + 1
    P = P | Di
    goto Int1
end
    
```

Finish DE's (Differential Equations):

$$g(x, y(x)), \frac{dy}{dx}, \frac{d^2y}{dx^2}, \dots, \frac{d^ny}{dx^n} = 0$$

Have higher probability to be selected for the next generation in TM where  $n \in z^+$  is order of DE's. To compute the fitness of each chromosome is by calculate fitness probability,  $fp(x)$ , then we add one to the fitness probability  $fp(x)$  for avoid divide by zero where (Eq. 4):

$$ft(x) = \frac{1}{fp(x)+1} \tag{4}$$

And where fitness probability is (Eq. 5):

$$f(x_1) = D(x_1, y)(x_1), \frac{dy}{dx}$$

$$\left| x = x_1, \frac{d^2y}{dx^2} \right|_{x=x_1}, \dots, \left| \frac{d^ny}{dx^n} \right|_{x=x_1}$$

A <sub>0</sub>	D <sub>11</sub>	A <sub>3</sub>	D <sub>2</sub>	D <sub>10</sub>	D <sub>12</sub>	D <sub>1</sub>	C <sub>2</sub>	A <sub>0</sub>	A <sub>4</sub>	C <sub>4</sub>	A <sub>3</sub>	D <sub>2</sub>	BN <sub>15</sub>
0	11	3	2	10	12	1	2	0	4	4	3	2	15
0	B	3	2	A	C	1	2	0	4	4	3	2	F

Table 5: Fitness chromosome

Types	Frequency appear
a sin(bx)	8
a cos(bx)	8
a exp(bx)	8
ax <sup>t</sup>	8
ax	1
a ln(x)	1
a log(x)	1
ax	1
a	1

**Algorithm 4; population Technique for TM:**

```

Input:      n size of population
           t the number terms
           a minimum number value
           b maximum number value
           ε small number 0<ε<<1

Output:    sequence of production.

0.  h = 0, xi = a+b/2
1.  while h<=n
2.  z = 0, w = 0, s = 0, f = 0
3.  for j = 1 to t
4.  Pij = 03
5.  r = random (0,1) //Generate
   random number r, 0 = r = 1
6.  k = 13 [r+0.75+0.25z] -11
7.  call A1
8.  if z = 0 and r<0.25
9.  z = 1
10. Pij = Pij || |D| | F
11. term (i, j) = m
12. continue
13. end
14. Pij = Pij || |D| | 2
15. e = m
16. k = 2 [(3-w)r]-2
17. Pij = Pij || k
18. if w = 0
19. Pij = Pij || F
20. w = 1
21. term (I, j) = e*x
22. continue
23. end
24. if k = 0
25. s = s+1
26. call A1
27. Pij = Pij || 443 |D| | F
28. C = [m]
29. u (s) = c
30. while u (L) = u(s) L = 1, 2, ..., s-1
31. call A1
32. end
33. term (I, j) = e*xc
34. continue
35.
36. End
37. if k = 2

```

```

38. Pij = Pij || 2
39. f = f+1
40. if f = 1
41. r = random (0, 1)
42.
43. v (1) = k
44. else
45. A2: r = random (0, 1)
46. L = 1
47. While v (L) = [6r]
48. L = L+1
49. end
50. if L<f
51. Goto A2
52. end
53. k = [6r]
54. v(f) = k
55. end
56. Pij = Pij || k
57. Call A1
58. Pij = Pij || 3 || D || 2 || 4 || 1 || F
59. Term (I, j) = e * fi(mx)
60. end
61. T(x, I) = T (x, i)+Term (i, j)
62. if ft (xi) <ε //see equation (4.4)
63. h = h+1
64. Fterms (x, I) = T (x, i)
65. end
66. end
67. end
68. A1: Call algorithm (4.2)
69. return random number a<m<b
70. and sequence
71. end A1
72. f0 (x) = sin (x)
73. f1 (x) = cos (x)
74. f2 (x) = exp (x)
75. f3 (x) = log (x)
76. f4 (x) = sqrt (x)

```

Algorithm 4 for using turing machines and development of grammatical evaluation to selection n functions Fterms (x, i) where i = 1, 2, ..., n. Suppose, the number terms in the function f(x) is t, the number of types terms functions T<sub>f</sub> and the number frequency appears of each type term in the function f(x) by the following Table 4. where, n<sub>i</sub> = 1, 2, ..., ∞, I = 1, 2, ..., T<sub>f</sub>, then, if n<sub>i</sub> = ∞, that mean n<sub>i</sub> is unbounded selection if the number of unbounded selection terms is u where u<T<sub>f</sub>, let N<sub>if</sub> denoted to the number of class functions f(x) for t terms. Suppose u = 4, T<sub>f</sub> = 9, then p = 9-4 = 5 and the number of frequency appears for each type term by the following (Table 6-7).

Table 6: No. of functions

No. of function	Term type	a	b	Term type	a	b	Term type	a	b
1	6	1.652401	0	3	31.81481	7.574575	1	394490.1	-0.82962
2	4	-584.837	-6.72358	3	-859.05	3.513305	4	84040.6	-4.79501
3	5	1.475907	0	2	-441.614	2.776458	6	2.460912	0
4	3	-582.41	1.965864	4	-164.374	9.890553	6	-65.4199	0
5	1	865.6072	-6.64921	5	-2.19092	0	3	3.507939	3.818017
6	2	-887.2	3.94388	5	-1.4764	0	6	4.429936	0
7	4	448.6314	8.66316	3	-91.8146	0.139788	1	3380.286	-7.67544
8	2	1040.349	-4.66	1	290.1992	-0.45115	4	-239.74	-8.30968
9	3	-110.409	-0.52447	5	0.57883	0	6	-1.2585	0
10	5	8.408849	0	1	-762.876	-8.99161	4	1879.738	-6.05705
11	3	349.937	7.020979	3	240.0716	6.270517	2	4508447	9.159198
12	5	7.062136	0	4	635.3941	3.987232	6	0.748992	0
13	5	2.946883	0	6	5.633692	0	1	4121.553	8.231961
14	5	-4.53996	0	4	-354.754	7.692445	4	112.8967	9.465998
15	5	2.331542	0	3	44.20943	3.442064	2	19793.89	-4.1783
16	5	-1.87106	0	4	-694.063	-5.62833	2	-1039.18	7.535217
17	1	-838.03	-9.14302	5	-8.87781	0	3	-3.14296	4.696789
18	4	-172.981	-9.39282	6	3.177752	0	5	-5.63629	0
19	5	0.956839	0	3	-82.2317	6.680984	3	4.91E+08	-7.82789
20	1	-621.425	-4.389	6	3.895267	0	5	-8.24643	0

Table 7: Frequency

Types	Function
1	a sin(bx)
2	a cos(bx)
3	a exp <sup>bx</sup>
4	a x <sup>a</sup>
5	ax
6	a

Table 8: The types of terms are

Types	Function
1	a sin(bx)
2	a cos(bx)
3	a e <sup>bx</sup>
4	a x <sup>b</sup>
5	ax
6	a

Suppose:

$$n_t = \alpha \left[ \frac{\alpha}{t} \right] + p \left[ \frac{\beta}{\beta+1} \right]$$

$$\alpha = t \text{ mod } (p+1), \beta = \left\lfloor \frac{t}{p+1} \right\rfloor$$

Then:

$$N_{if} = \sum_{i=0}^{n_t} \binom{p}{i} u^{t-i} \tag{6}$$

For p = 5, t = 3, then  $N_{if} = \sum_{i=0}^3 \binom{5}{i} 4^{3-i}$  classes but there

exist infinite function of three terms. From (4.7) if t = p, then  $N_{if} = (1+u)^p$

**Example 0:** By using the above algorithm () where n = 20, t = 3, T<sub>f</sub> = 9, u = 4, p = 5 and differential equation is:

$$Y'' - 100y = 0, y(0) = 0 \text{ and } y'(0) = 10$$

### CONCLUSION

In this study we offer a new method similar to the work of the method of grammatical evolution but do not depend on it where the use of mod and speed of the solution and less steps and a small storage grammatical evolution deepened on the conversion of chromosomes into functions according to certain rules. These functions are considered candidate solutions.

### REFERENCES

Back, T. and F. Hoffmeister, 1991. Extended selection mechanisms in Genetic algorithms. Proceedings of the 4th International Conference on Genetic Algorithms and their Applications, (GAA'91), Morgan Kaufmann Publishers Inc., San Diego, CA., USA., pp: 92-99.

DeJong, K.A., 2006. Evolutionary Computation: A Unified Approach. MIT Press, Cambridge, Massachusetts, USA., ISBN:9780262041942, Pages: 268.

Goldberg, D.E., 1989. Genetic Algorithms in Search, Optimization and Machine Learning. 1st Edn., Addison-Wesley Professional, Boston, MA., USA., ISBN-13: 9780201157673, Pages: 412.

Holland, J.H., 1975. Adaptation in Natural and Artificial System. University of Michigan Press, Ann Arbor, USA.

Jebari, K. and M. Madiafi, 2013. Selection methods for Genetic algorithms. Intl. J. Emerging Sci., 3: 333-344.

Kumar, R. and Jyotishree, 2012. Effect of polygamy with selection in Genetic algorithms. Intl. J. Soft Comput. Eng., 2: 194-199.

Kumar, R., G. Gopal and R. Kumar, 2013. Hybridization in Genetic algorithms. Intl. J. Adv. Res. Comput. Sci. Software Eng., 3: 403-409.



- Michalewicz, Z., 2007. Genetic Algorithms + Data Structures = Evolution Programs. 3rd Edn., Springer, Berlin, Germany, ISBN:978-3-642-08233-7, Pages: 383.
- Mitchell, M., 1998. An Introduction to Genetic Algorithms. MIT Press, Cambridge, Massachusetts, USA., Pages: 203.
- Razali, N.M. and J. Geraghty, 2011. Genetic algorithm performance with different selection strategies in solving TSP. Proceedings of the 2011 International World Congress on Engineering Vol. 2, July 6-8, 2011, WCE, London, UK., ISBN:978-988-19251-4-5, pp: 1134-1139.