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Selection Technique of Genetic Algorithm in Turing Machine

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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

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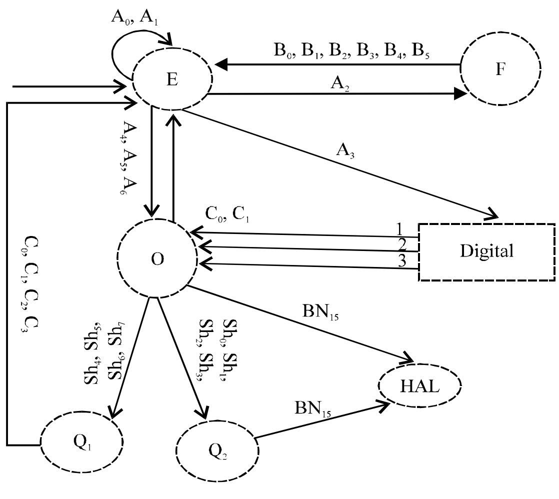

Fig. 1: Turning machine of grammatical evolution

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 040010100443203153450033 24F and function:

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

where, N_t = 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 $p = \{p_1, p_2, \ldots,\}$, applied in one of TM set into the set functions $F = \{f_1, f_2, \ldots,\}$ define by TS: P×TM→F

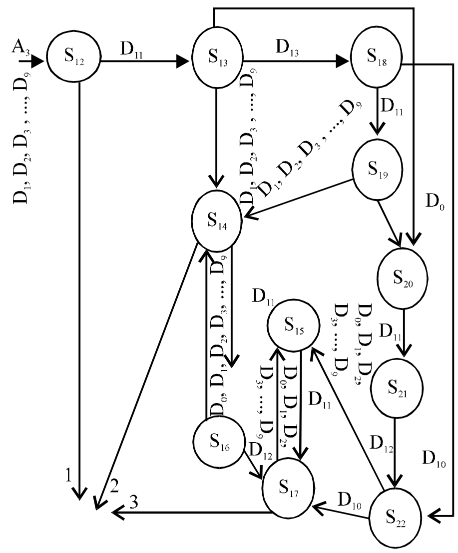

Fig. 2: Turning machine of digital number

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:

A_0	A_4	C_4	A_0	A_3	D_2	C_0	A_2	B_0	A_4	Sh_1	BN_{15}
0	4	4	0	3	2	0	2	0	4	1	15
0	4	4	0	3	2	0	2	0	4	1	F

Table 1: Production rules and symbols

Samples	Definition
A_0	0/EOE/N
A_1	1/(E)/R
A_2	2/F(E)/N
A_3	3/D/N
A_4	4/x/R
A_5	5/y/R
A_6	6/z/R
B_0	0/sin/R_4
B_1	1/cos/R_4
B_2	2/exp/R_4
B_3	3/log/R_4
B4	4/sqrt/ R_5
B5	5/ln/ R_3
C_0	0/+/R
C_1	1/-/R
C_2	2/*/R
C_3	3/÷/R
C_4	4/^/R
D_0	0/0/R
D_1	1/1/R
D_2	2/2/R
D_3	3/3/R
D_4	4/4/R
D_5	5/5/R
D_6	6/6/R
D_7	7/7/R
D_8	8/8/R
D_9	9/9/R
D_{10}	10/D/N
D_{11}	11/DD/N
D_{12}	12/. /R
D_{13}	13/-/R
D_{14}	14/ π /R
SH_0	0/N
SH_1	1/R
SH_2	2/R2
SH_3	3/R3
SH_4	4/N
SH_5	5/R
SH_6	6/R2
SH_7	7/R3
BN15	15/B/N

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_2 B_0, A_0, A_4, C_0, A_3, D_3, BN_{15}, this corresponding of the sequence 2004033F and function sin (x+3) then by Table 2:

Table 2: Calculation the number of terms

Symbols of expression	Expression	Unknown operation (U_N)	No. of terms (N_t)	Trace of operation (T_{op})
A_0	EOE	1	1	0
A_3, D_2	2OE	1	1	0
C_2	2*E	0	1	0
A_0, A_4	xOE	1	1	0
C_4	X^E	0	1	0
A_0, A_3, D_2	X^{2OE}	1	1	0
C_1	X^2-E	0	2	0
A_0, A_3, D_3	3OE	1	2	0
C_2	3*E	0	2	0
A_0, A_2, B_0	Sin(E)OE	1	2	1
A_0, A_4	Sin(xOE)OE	2	2	1
C_0	Sin(x+E)OE	1	2	1
A_0, A_3, D_3	Sin(x+3OE)OE	2	2	1
C_2	Sin(x+3*E)OE	1	2	1
A_5, Sh_1	Sin(x+3y)OE	1	2	0
C_0	Sin(x+3y)+E	0	3	0
A_0	+EOE	1	3	0
A_3, D_2	2OE	1	3	0
C_2	2*E	0	3	0
A_4	2*E	0	3	0
BN_{15}	2*x	0	3	0

A_2	B_0	A_0	A_4	C_0	A_3	D_3	BN_{15}
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_0 A_1, A_0, A_4, C_0, A_5, Sh_5, C_4, A_3, D_3, NB_{15}, this corresponding of the sequence 0104055433F and function $(x+y)^3$ 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:

$$A_0, A_0, A_3, D_{11}, D_2, D_5, D_{10}, D_{12}, D_1, D_{10}, D_1, C_2, A_4, C_4, A_0, A_3, D_3, C_1, A_0, A_3, D_3, C_2, A_0, A_4, C_4, A_0, A_3, D_2, C_0, A_0, A_3, D_2, C_2, A_0, A_4, C_0, A_3, D_{11}, D_1, D_1, BN_{15}$$

A_0	A_1	A_0	A_3	C_0	A_5	Sh_5	C_4	A_3	D_3	BN_{15}
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.
003B25AC1A1244033103320440320032204 03B11F

And function:

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

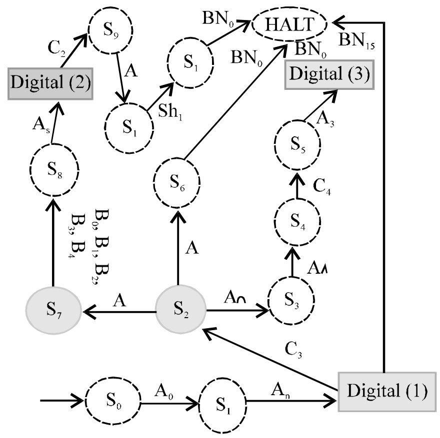

Fig. 3: Standard simple terms

Where:

$$N_{t-} = 4, N_{pm-} = 3 \text{ and } N_{op-} = 8$$

Example (4.5): From Fig. 2, 3 and Table 1, the sequence A_0, A_0, A_3, D_6, C_2, A_4, C_0, A_0, A_1, A_0, A_4, C_0, A_3, D_1, Sh_1, C_4, A_3, D_2, BN_{15}, this corresponding of the sequence 0036240010403 11432F and function $6x+ (x+1)^2$.

Where:

$$N_{t-} = 2, N_{pm-} = 2 \text{ and } N_{op-} = 4$$

Example (4.6): From Fig. 1 and 2, Table 1, the sequence:

$$A_0, A_4,$$
$$C_0, A_0, A_2, B_0, A_0, A_4, C_0, A_3, D_1, Sh_1,$$
$$C_1, A_0, A_1, A_0, A_1, A_0, A_0, A_4, C_4, A_3,$$
$$D_2, C_0, A_3, D_1, Sh_5, C_3, A_4, Sh_5,$$
$$C_0, A_0, A_3, D_3, C_2, A_4, BN_{15}$$

Congruent sequences production rules

Definition (4.3): The sequence S_{Q1} is a congruent to the sequence S_{Q2}, if and only if the functions corresponding to the sequences S_{Q1} and S_{Q2} are equal. Denoted by $S_{Q1} \cong S_{Q2}$

Example (4.7): Let $f(x) = x^2 +5$ and $g(x) = 1*x^2- 0+5$, the sequence S_{Q1} of f(x) is A_0, A_4, C_4, A_0, A_3, D_2, C_0, A_3D_5, BN_{15}. And the sequence S_{Q2} of g(x) is A_0, A_3D_1, C_2, A_0, A_4, C_4, A_0, A_3, D_2, C_1, A_0, A_3, D_0, C_0, A_3, A_5BN_{15}. Since, f(x) = g(x), then $S_{Q1} \cong S_{Q2}$. In above example where remove A_3, D_1, C_2, A_0, and C_1, A_0, A_3, D_0, from S_{Q2}, then $S_{Q1} = S_{Q2}$.

Definition (4.4): If S_{Q1} and S_{Q2} are sequences of production rules, then the definition of the function $\eta(S_{Q1})$ is a sequence of production rules such that $\eta(S_{Q1}) = S_{Q2}$.

Note: The function η to remove identity from sequence for each operations:

- Addition and subtraction: $a = a\pm0 = 0\pm a$
- Multiplication and division: $a = 1*a = a*1$, $a = a/1$
- Power: $a = a^1$

Note: Equivalent functions, for example, $x+x = 2x$, $\sin(\phi+\pi) = -\sin(\phi)$, ...

MATERIALS AND METHODS

The number of terms in function: The aim of this study to calculate the number of terms in sequence of production rules corresponding to function. In mathematics algebra the term is either a single number (belong to real number) or variable (x, y, …,) or numbers and variables multiplied together (3x, 5.1y, …,). The terms are separated by plus operation (+sign) or minus operation (-sign). To calculate the number of terms by summation the number plus and minus out of brackets (Table 3 and 4). The algorithm to find the number of terms in sequence of production rules where the following calculation:

$$A_0, A_3, D_2, C_2, A_0, A_4, C_4, A_0,$$
$$A_3, D_2, C_1, A_0, A_3, D_3, C_2, A_0, A_2,$$
$$B_0, A_0, A_4, C_0, A_0, A_3, D_3, C_2, A_5,$$
$$Sh_1, C_0, A_0, A, D_2, C_2, A_4, BN_{15}$$

Table 2 calculation the number of terms. The number of terms is (N_t) 3 and the function is $2x^2-3\sin(x+3y)+2x$ where.

Trace of operation: To check cursor of calculation inside bracket or outside and denoted by T_{Op}.

Unknown operation: Just only operand but unknown the operation and denoted by U_N. The number of terms, initial first value is one. Now by using the following, example for calculate number of terms in the following sequence (algortihm 1):

Algorithm 1; Calculate the number of terms in production sequence S:

```
Input: production sequence S_Q = q1q2q3, …, qm
Output: the number of terms N_t.
1.        i = 1, N = 1, T_op = 0, U_N = 0
2.   while i ≤ m
       if qi == A_0
                 U_N = U_N+1
         if qi ∈ {C_0, C_1, C_2, C_3, C_4}
                U_N = U_N -1
        if (qi == C_0 or qi == C_1) and T_op = 0
             N_t = N_t+1
         if qi ∈ {B_0 , …, B_5} or qi == A_1
               T_op = 1
                     if q i ==  Sh_1
                     T_op = 0
3.   return N_t
```

Table 3: Production rules and symbols for simple term

Sample	Definition	No.	Sample	Definition
A_0	0/ EOE/N	16	D_2	2/2/R
A_2	2/ F(E)/N	17	D_3	3/3/R
A_3	3/D/N	18	D_4	4/4/R
A_4	4/x/R	19	D_5	5/5/R
B_0	0/sin/R_4	20	D_6	6/6/R
B_1	1/cos/R_4	21	D_7	7/7/R
B_2	2/exp/R_4	22	D_8	8/8/R
B_3	3/log/R_4	23	D_9	9/9/R
B4	4/sqrt/ R_5	24	D_{10}	10/D/N
B5	5/ln/ R_3	25	D_{11}	11/DD/N
C_0	0/+/R	26	D_{12}	12/. /R
C_1	1/-/R	27	D_{13}	13/-/R
C_2	2/*/R	28	D_{14}	14/ ð /R
C_4	4/^/R	29	SH_1	1/R
D_0	0/0/R	30	BN15	15/B/N
D_1	1/1/R			

Table 4: Number of terms in production

Type	T1	T2	…	T_{rf}
Frequency appear	n_1	n_2	…	n_{rf}

Standard simple terms

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

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

Power Function (PF): A x^n where $a\in\mathbb{R}$ and $n\in\mathbb{R}$ such as.

Line Function (LF): A x^n where, $a\in\mathbb{R}$ 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:

$$\Gamma = \{A_0, A_2, A_4, B_0, \&B_5, D_0, D_1, ..., D_9, D_{11}, D_{12}, D_{14}, Sh_1, BN_0\}\ |S| = 27$$

Selection random simple term: To select a random term from Fig. 3 and 2 by generate random digit in States S2, S7 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_{15}) and other C_2 (have three paths in State S2), then there two paths k = 15 for BN_{15} and k = 2 for C_2, if r random between 0 and 1, then generate random k where (Eq. 1):

$$k = 28-13\lceil r+0.75\rceil, 0<r<1 \quad (1)$$

In state S2 of Fig. 3, the random number 0, 2 and 4 if r random between 0 and 1, then generate random A_k where (Eq. 2):

$$k = 2\lceil 3r\rceil-2, 0<r<1 \quad (2)$$

In state S7 of Fig. 3, the random is 0, 1, 2 , 3, 4 and 5, if r random between 0 and 1, then generate random B_k where (Eq. 3):

$$k = \lfloor 6r\rfloor, 0<r<1 \quad (3)$$

$$\min\beta, \qquad \beta\geq 0$$
$$\text{Such that} \qquad 10^\beta D_p-\lfloor 10^\beta D_p\rfloor = 0$$

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 $I_p(x)$ and decimal part $D_p(x)$,

Integer part: To calculate the sequence of α decimal places of integer part of x is I_p where:

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

Example(4.8): If x = 528.25, then $I_p(x) = |\lfloor 528.25|$ = 528. The number of digit in I_p is α where, (Eq. 4):

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

From above example $\alpha = \lceil\log_{10}(528)\rceil$ = 3. The decimal places of I_p from left to right are :

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

Where:

$$I_k = \lfloor 10^{1-k} X_{a-k+1}\rfloor, k = \alpha, \alpha, -1, ..., 2, 1$$
$$x_{k+1} = x_k - 10^{\alpha-k} I_{\alpha-k+1} x_1 = I_p$$

From above example:

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

Example (4.9): If x = -368<0, then I_p = 368 and α = [log_10(368)] = 3, then $I_1 = 8.I_2 = 6.I_3 = 3$.

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 β is minimum value of. From above example $D_p = 0.25$, then $10^2\, 0.25-\lfloor 10^2 \times 0.25 \rfloor = 0$ $\beta = 2$. 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:

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

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

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

Where:

$$x_1 = D_p$$

From above example:

$$x_1 = 0.25, d_1 = \lfloor 10 x_2 \rfloor = 2$$

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

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 ,…, I α, d1,d2 ,…, dβ
4-   if x>0
                    if α = 1 and β = 0
                          P = P|| Dl1
                        goto finsh
       end
      P = P|| D11
      I = i+1
     P = P|| Dli
Int1:        while i ! = α-1
               P = P|| D11
               i = i+1
              P = P|| Dli
     end
     if β = 0
               i = i+1
              P = P||DIi
             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
```

RESULTS AND DISCUSSION

Generate sequence of $I_0, I_1, I_2, \ldots, I_\alpha$ and $d_1, d_2, \ldots, d_\beta$: From Fig. 2 for every number $x \in \mathbb{R}$, there are sequence $I_0, I_1, I_2, \ldots, I_\alpha, d_1, d_2, \ldots, d_\beta$ corresponding to production sequence $D_{11}, D_{12}, \ldots, D_{1\varsigma}$ for example 83.52 where $I_1 = 3$, $I_2 = 8$, $d_1 = 5$ and $d_2 = 2$, corresponding $D_{11}, D_8, D_{11}, D_3, D_{11}, D_{12}, D_5, D_{11}, D_2$ 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||DIi
    goto Int1
end
```

Finish DE's (Differential Equations):

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

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):

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

$$\left| x = x_i, \frac{d^2y}{d^2x} \right|_{x = x_i}, \ldots, \left. \frac{d^ny}{d^nx} \right| x = x_i$$

A_0	D_{11}	A_3	D_2	D_{10}	D_{12}	D_1	C_2	A_0	A_4	C_4	A_3	D_2	BN_{15}
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^n	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.
h = 0, x1 = a+b/2
while h< = n
z = 0, w = 0, s = 0,f = 0
for j = 1 to t
     Pij = 03
      r = random (0,1)          //Generate
 random number r, 0 = r = 1
k = 13 ⌈r+0.75+0.25z⌉ -11
     call A1
      if z = 0 and r<0.25
             z = 1
                         Pij = Pij | |D| | F
                         term (i, j) = m
                         continue
                   end
                   Pij = Pij | |D| | 2
                   e = m
                   k = 2⌈(3-w)r⌉-2
                   Pij = Pij | | k
                    if w = 0
                         Pij = Pij | | F
                         w = 1
                         term (I, j) = e*x
                         continue
                     end
                    if k = 0
                         s = s+1
                          call A1
                          Pij = Pij | | 443 | |D| | F
                           C = ⌊m⌋
                          u (s) = c
                            while u (L) = u(s) L = 1 ,2 , ..., s-1
                            call A1
                            end
                          term (I, j) = e*x^c
                         continue

                     End
          if k = 2
                         Pij = Pij | | 2
                         f = f+1
                         if f = 1
                              r = random (0, 1)

                              v (1) = k
                           else
                   A2:       r = random (0, 1)
                               L = 1
                               While v (L) = ⌊6r⌋
                                      L = L+1
                                    end
                                   if L<f
                                        Goto A2
                                   end
                              k = ⌊6r⌋
                                   v(f) = k
                               end
                              Pij = Pij | | k
                              Call A1
                                   Pij = Pij | | 3 | | D | | 2 | | 4 | | 1 | | F
                              Term (I, j) = e * fk(mx)
                         end
                         T(x, I) = T (x, i)+Term (i, j)
                         if ft (x1) <ε  //see equation (4.4)
                          h = h+1
                           Fterms (x, I) = T (x, i)
                           end
                      end
                   end
                    A1: Call algorithm (4.2)
                              return random number a<m<b
                              and sequence
                     end A1
                    f0 (x) = sin (x)
                    f1(x) = cos (x)
                    f2(x) = exp (x)
                    f3(x) = log (x)
                    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_f and the number frequency appears of each type term in the function f(x) by the following Table 4. where, n_i = 1, 2, ..., ∞, I = 1, 2, …, T_f , then, if n_i = ∞, that mean n_i is unbounded selection if the number of unbounded selection terms is u where $u<T_f$, let N_{tf} denoted to the number of class functions f(x) for t terms. Suppose u = 4, T_f = 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 $\exp^{bx}$
4	a x^n
5	ax
6	a

Table 8: The types of terms are

Types	Function
1	a sin(bx)
2	a cos(bx)
3	a e^{bx}
4	a x^b
5	ax
6	a

Suppose:

$$n_t = \alpha\left\lfloor \frac{\alpha}{t} \right\rfloor + p\left\lceil \frac{\beta}{\beta+1} \right\rceil$$

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

Then:

$$N_{tf} = \sum_{i=0}^{n_t} \binom{p}{i} u^{t-i} \qquad (6)$$

For p = 5, t = 3, then $N_{tf} = \sum_{i=0}^{nt} \binom{5}{i} 4^{3-i}$ classes but there exist infinite function of three terms. From (4.7) if t = p, then $N_{tf} = (1+u)^p$

Example (): By using the above algorithm () where n = 20, t = 3, T_f = 9, u = 4, p = 5 and differential equation is:

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

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.

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