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University Courses Scheduling Using Cat Swarm Optimization Algorithm

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Abstract
This paper presents a new algorithm the for handling scheduling courses problems in universities. This algorithm namely Cat Swarm Optimization(CSO) simulates the conduct of cats. There are two modes of this algorithm : Seeking and Tracing. Such algorithm relies on Cats swarm optimization technology which simulates the demeanor of at Simulation result prone the elect times of the proposal algorithm it is recommended to apply this smart to change in differ schedule and limits tables to Saving time & effort.

Keywords
University Course Timetabling Problem, Cat Swarm Optimization (CSO), Seeking Mode, Tracing Mode.

I. Introduction

Most human activities require a certain type of Timetabling in terms of distribution activities at the existing tasks and By available resources with the need to respect certain restrictions or limitations and abide by. The problem Timetabling of lessons in educational institutions of the basic examples in this direction [1]. show Timetabling issue at the beginning of each school year, educational institutions are used as universities and schools Timetabling to schedule lectures and classes. It is very hard to determine the validity of Timetabling and quality, Easy to fix a time when Timetabling be unsuitable for use, and to consult with an experienced person to the question of timetables is very easy to fix situations To be avoided Order to obtain the almost perfect result [2]. I have gained the problem of software and computer systems development to deal with the issue Timetabling wide attention from the scientific forums for 50 years, The reason for this treatment of a specific case of the problem of Timetabling and once a year at least, And processing by hand require a number of manpower. And more importantly, he in a lot of cases there is a need to be ideal Timetabling according to a set of calibrated help, and this issue is more difficult to Generate a practical and simple Timetabling [3]. And devoted international competitions timetables of educational institutions including The Third International Timetabling Competition [4] In 2012. Timetables is an area he studied on a larger scale, Many of the algorithms used in this area that would be helpful solution the problem tables university courses, Will be applied in this study Cat Swarm Optimization algorithm. It was relying on optimization algorithms based on swarm intelligence. In this study, we have proposed an algorithm motivated by PSO, ACO, According to the literatures, PSO Always appears better and faster results, depending on the results of the tests conducted at the source [5], and the test results showed that CSO in a much better performance PSO. By observing the behavior of creatures, you can get a good idea to solve optimization problems. And studying the flight and the movements of gulls by idea PSO, and by observing the behavior of ants achieved ACO , by the conduct of the cat control achieved our CSO. We are in this study we used, CSO which is one of the Intelligence swarm algorithms. Created Monitoring cat behavior , and it consists of two sub-models, i.e., tracing mode and seeking mode, which model upon the behaviors of cats.

II. Previous Works

The evolutionary algorithm the design and function of Fitness. And propose a strategy of random selection and arrangement so as to make a significant convergence rate of Population. [2, 6].
This study tried to implement the original to Determine its strengths and weaknesses in dealing with examination schedule domain [7].
Artificial Bee Colony is modified for post-enrolment course timetabling problem. The adjustment in the adjusted onlooker bee included by the use of multiple switching algorithms to be a substitute for her client . This modification enables the modified-Artificial Bee Colony to explore post-enrolment timetabling search space more efficiently. [8 - 10].
swarm optimization to enhance the global exploration ability while hybridizing with the great deluge algorithm to improve the local exploitation ability. Using this style an effective balance between exploration and exploitation is attained. [11].
Dynamic constraint matching (DCM) to occupy various restrictions from the University of course schedules and problems combined with Vertex graph coloring (VGC) approach. [12]
Genetic Algorithms: This algorithm is presented in two phases, the first phase is the establishment of two types of the population and the selection of the best solution. The second phase of the random number generation solutions are mating and the selection of the optimal solution, which represents the best chromosome. And can learn more about Genetic Algorithms and the applications on the schedules in sources [13, 14, 15, 16].
Constraint-based Methods: And rely on logic-based planning system on the Enrollment, where the formulation of the problem of schedules in an object oriented approach[17].
Graph-based Approaches: This method is used to solve the problem the teacher, and for their ability to deal with a lot of separate groups of lectures [18].

III. Cat Swarm Optimization

A new algorithm of intelligent algorithms Squadron. And be two models Seeking mode' and 'Tracing mode'. And monitor cats behavior, it turns out that there is a common behavior among them in the real world for these two modes. and Here employ cats that act as particles in the solution of problems [19]. In CSO all cat for him D dimensions, velocities for every dimension, a fitness worth, and who represents the role of the cat in fitness, and identify put the cat Are in put Seeking mode or Tracing mode. The final solution would be in better of one of the cats position. The CSO keeps better solution Even up to the end of the repetition

IV. Problem Definition

One of the most common problems in the face of human Scheduling is a problem which is a search requires people treated almost daily, Whether it conducted continuously or otherwise. Generally , Every problem that is aimed at matching set of temporal entities for a range of activities described as a problem Scheduling. There is a subclass of scheduling problems known as Assignment - Type problem. Timetabling problem is an example of the problem Assignment [20]. Timetabling and is characterized by the presence of too many restrictions and limitations as well as the difficulty of problems solved. It can be defined as the distribution of certain substances (lessons for teachers) on certain things (rows and halls) within certain time and place in a manner that will meet as much as possible of the desired goals [11],[21],[22]. In other words, Timetabling process that aims to help its users to be in place and time properly. The scheduling problems Play An important role in the area of education, Is a special edition of Optimization problems in real-life situations, And was always a problem is resolved Timetabling through the advancement of the level of human resources in educational institutions, During this process should take into account many aspects, Expert needs to be a week or more in the creation of Timetabling, However, the result is often not satisfactory as it does not meet all the requirements, As well as change caused by pre-conditions that lead to the entire work to be unusable and have to be brought back again [22].

Examples of timetables problems are:

Educational Timetabling
Transport Timetabling
Employee Timetabling
Sports Timetabling
Complexity Issues
Distributed Timetabling Systems
Scheduling experiences
Commercial Package
Interactive Vs Batch Timetabling
Timetabling Update
Scheduling experiences

Previous uses have been reason to devote a great deal of attention to the Automated scheduling appointments, During last year's fifty, And starting in 1963 published many research on the electronic scheduling appointments in journals and conferences & workshops [20, 21, 23].

In this paper, using the Cat algorithm Swarm Optimization (CSO), The Faculty of Science, Mathematics Department, Mansoura University in Egypt as a sample test and development to solve the problem schedules for universities,

Where each student can be registered here in the next phase Courses Two courses out of Three courses are optional, And that this thing is a problem which is to be lecturer at the same time phase of lectures and lectures the next phase, which recorded cycle or the Two courses. this one that concerns the students, And do not forget the halls, And her spare time, because the halls are not a particular section but shared with Sections college, It can also be shared with other colleges and this is considered one of the biggest obstacles we have. And with respect to professors also certain times an example of our human rights rapporteur and a professor who teaches this article from the Faculty of Law and not from the Faculty of Science must therefore respect the time that suits him to deliver a lecture on the section students in the Faculty of Science and considered these difficult problems. This main problems for research, But there are a number of determinants that can characterize it to [1, 2,7,11,22,25

A. Hard Restrictions

1. Professors and the right time for them and courses Studied by.
2. halls and her spare time.
3. Students cannot be for the student to ban more than a lecture at the same time.
4. always beginning and an end.
5. Number of compulsory and optional courses that cannot be manipulated or overlooked.

B) Soft Restrictions

1. times of lectures.
2. lunch break.
3. The distribution of the number of daily hours of lectures.
4. Number of lectures every day.

Mathematical representation of the problem of timetables

In order to get a more accurate idea about what needs to be his account of the question university appointments that are under treated tables, it must be represent a mathematically, as follows: Suppose that there are N of courses, teachers and M, and L of the halls, as well as work days per week and periods of teaching per day.

Week days ={ Saturday, Sunday, Monday, Tuesday, Wednesday },

It could be a the time period = {8:30 ..... 4:30 }.

Each course i-th, ($1 \le i \le N$) There are a number of signs and is in accordance with the following:

V_i : Approximate number of students in teaching material i-th .

l_i : Number of lectures teaching material i-th .

p_{ij} : The number of meetings (the length of time for the lecture) to lecture j-th of teaching material and the i-th Represented ($1 \le i \le l_i$).

t_i : The number of teachers teaching material for the i-th.

n_{ij} : Teacher j-th teaching material for the i-th ($1 \le j \le t_i$, $1 \le n_{ij} \le M$).

d_i :The number of separate courses (non-conflicting) with teaching material i-th.

s_{ij} :Teaching material separated j-th teaching material with i-th

($1 \le j \le d$, $1 \le s_{ij} \le N$, $s_{ij} \ne i$) .

us_i: Number length of time (u-slots) is available for teaching material i-th.

dus_{ij} : Day Duration non-available time (u-slots) j-th The material subjects i-th ($1 \le j \le us$, dus_{ij} ε Days).

pus_{ij} : Lecture time period in non grata (u-slots) j-th The material subjects i-th ($1 \le j \le us_i$, pus_{ij} ε periods).

And relation to the teacher i-th ($1 \le i \le M$) The marks on according to the following :

ut_i : Number of non-available time period (u-slots) for the teacher i-th .

dut_{ij} : Time duration non available for today (u-slots) j-th teacher i-th.

($1 \le j \le ut_i$, dut_{ij} ε Days).

put_{ij} : Teaching period Time duration non available (u-slots) j-th teacher i-th

($1 \le j \le ut_i$, put_{ij} ε Periods).

Finally, specific signs of the halls i-the ($1 \le i \le L$) and are in accordance with the following:

C_i : Absorptive capacity of the hall i-th.

uc_i : Time duration non available (u-slots) for the hall i-th.

duc_{ij} : Time duration available for non-Day (u-slots) for the hall i-th , ($1\le j \le uc_i$, duc_{ij} ε Days) .

puc_{ij} : The period of study time duration unwanted (u-slots) j-th Hall of i-th,

($1\le j \le uc_i$, puc_{ij} ε Periods) .

What should account chasm time and place, And must tabulated according to each session of lectures sessions for each session, According to the following:

X_{ijk} : Day session k-th J-th of the lecture scheduled for i-th.

y_{ijk} : Duration Tuition for the session k-th of the lecture jth scheduled i-th.

Z_{ijk} : Hall special the session of the k-th lecture jth scheduled i-th, according to the following:

$1 \le I \le N$, $1 \le j \le l_i$, $1 \le k \le p_{ij}$, X_{ijk} ε Days , y_{ijk} ε Periods , $1\le Z_{ijk} \le L$

The restrictions that must be met, accordance with the representing the following:

1- It cannot occur two meetings at the same time and in the same room:

$$X_{ijk} \neq X_{i'j'k'} \vee y_{ijk} \vee y_{i'j'k'} \vee Z_{ijk} \neq Z_{i'j'k'}$$

$\forall$ i , j , k , i' , j' , k' With $1 \le i \le N$, $1 \le j \le l_i$, $1 \le k \le p_{ij}$, $1 \le i' \le N$, $1 \le j' \le l_{i'}$,

$1 \le k' \le p_{i'j'}$ and $i \neq i'$ or $j \neq j'$ or $k \neq k'$

2- lectures sessions must occur accordance with the successive periods of time on the same day and in the same room:

$$X_{ijk} = X_{j(k-1)}$$
$$y_{ijk} = \text{next } y_{ij(k-1)}$$
$$Z_{ijk} = Z_{ij(k-1)}$$

$\forall$ i, j, k with $1 \le I \le N$, $1 \le j \le l_i$ and $2 \le k \le p_{ij}$,

That (tp) next period of time after tp, Example

Next (10:00 – 11:00) = 11:00 – 12:00 .

2- Lectures should be a specific one article occur on different days:

$$X_{ijk} \neq X_{ij'k'}$$
$$\forall \text{ i, j, j'},$$

VI. Implementing the proposed method

In CSO, first you must specify the cats that want to use, and then apply them in CSO, to solve the problem. Each cat has its own dimensions, velocities for each dimension, a fitness worth, which represents the role of the cat in the function of fitness, and to identify the cat situation until it gets a better solution and up to the end of the repetition[19].

A. Seeking Mode

This sub-model is used for the case of the Table to the timetables models, which is resting, looking around and seeking the next position to move to. In seeking mode, we define four essential factors:

1. Seeking memory pool (SMP)

Used to define the size of seeking memory for each Table, which indicate the points sought by the Table. The Table would pick a point from the memory pool according to the rules described later.

2. Seeking range of the selected dimension (SRD)

Declares the mutatives ratio for the selected dimensions. In seeking mode, if a dimension is selected to mutate, the difference between the new value and the old one will not out of the range, which is defined by SRD.

3. Counts of dimension to change (CDC)

Discloses how many dimensions will be varied. These factors are all playing important roles in the seeking mode.

4. Self-position considering (SPC)

Is a Boolean variable, which decides whether the point, where the Table is already standing, will be one of the candidates to move to.

No matter the value of SPC is true or false; the value of SMP will not be influenced. How the seeking mode works can be described in 5 steps as follows [26, 19]:

Step 1: Make j copies of the current position of Tablek, whereas j = SMP. If the value of SPC is true, let j = (SMP-1), then Maintaining the status quo as one of the candidates.

Step 2: For each copy Has worked in step 1, according to CDC, randomly plus or minus SRD percents of the present values and replace the Value the old .

Step 3: In this step being the calculation of fitness values (FS) of every candidate points.

Step 4: If each FS It's not the same, calculate the selecting probability of each candidate point by equation(1), is set on the otherwise all about the possibility of choosing a candidate to be one point.

Step 5: Randomly pick the point to move to from the candidate points, and replace the position of Tabelk. This is shown in figure 1.

$$P_i = \frac{|\ FS_i - FS_b\ |}{FS_{max} - FS_{min}} \quad , \text{Where } 0 < i < j \qquad (1)$$

If the goal of the fitness function is to find the minimum solution, $FS_b = FS_{max}$, otherwise

$FS_b = FS_{min}$.

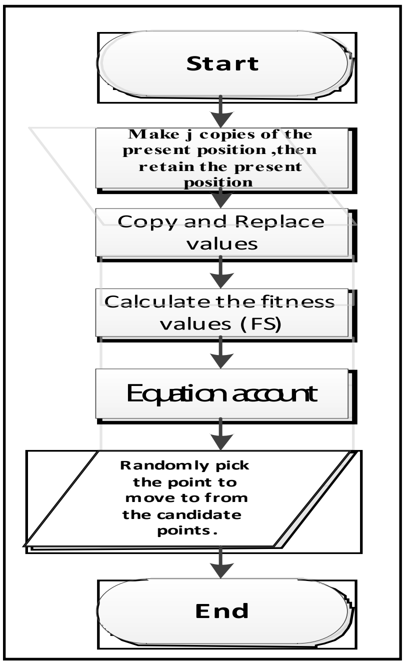

Fig.1 : The Seeking Mode Flowchart

B. **Tracing Mode**

Is the sub-model for modeling the case of the table in tracing some targets.

Once a Table goes into tracing mode , it moves according to its' own velocities for every dimension. The action of tracing mode can be described in 3 steps as follows [19] [26]:

Step 1:change the Speeds for every dimension (vk,d) According to equation (2).

Step 2: Ascertain whether the velocities are in the range of maximum speed. In case the new velocity is over-range, set it be equal to the limit.

Step3 Step 3: change the position of Tablek according to equation (3). This is shown in figure 2.

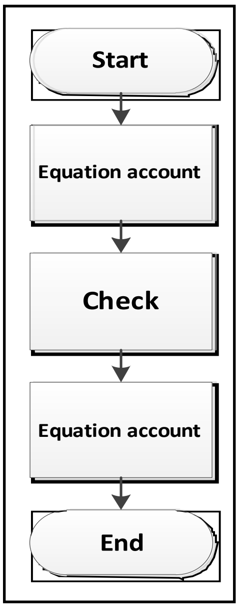

Fig. 2 : The Tracing Mode Flowchart

$$V_{k,d} = V_{k,d} + r_1 \times c_1 \times (X_{best,d} - X_{k,d}), where \quad d = 1, 2, 3, \dots, m \qquad (2)$$

$X_{best,d}$ is the position of the cat, who has the best fitness value; $X_{k,d}$ is the position of catk. c_1 is a constant and r_1 is a random value in the range of [0,1].

$$X_{k,d} = X_{k,d} + V_{k,d} \qquad (3)$$

VII. Procedures

As described and explained in the foregoing for the typical CSO sub, here we will combine two modes in the algorithm, and determine all situation through, Determine the proportion a mixture (MR) To join of the situation seeking mode and determine the status of tracing mode, and will work side by side in the algorithm . By observing the behavior of the cat, we note that most of the time spends cat at rest when it is awake.

While they are resting, they move their position carefully , sometimes slowly and even stay in the original position. Somehow, This behavior is to move to CSO, and the use of seeking mode to represent them, and the application of a row after goals cat tracing mode. Here we note that the value of MR is a small value for most cats spends in time to ensure seeking mode.

It can be described steps CSO 6 steps as follows:

Step1: Create N Tables in the process (As soon as they relate to the database we've created within the program take random restrictions from within the database) This is shown in figure3.

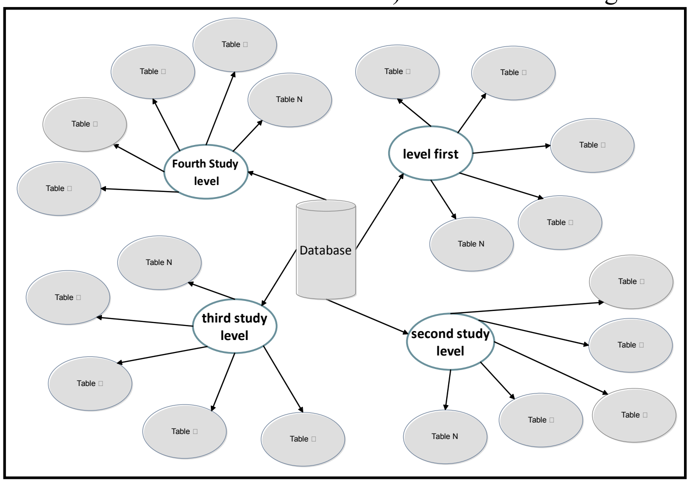

Fig. 3 : Process Connect to the database and generate random tables.

Step 2: Randomly distribution the Tables into the D-dimensional solution space and randomly select values, Taking the maximum extent for the scope of the restrictions solid. Then haphazardly pick the number of Tables, That have been created in step 1, And put it into the tracing mode according to MR, and the others set into seeking mode.

Step 3: In this step we assess the value of fitness every table which we distributed in the space of the solution d in step 2, and that through the application of the positions of tables, to the fitness , which represent all our goal standards, and after you save the best the table in memory. Note that we only need to remember a better position table (xbest)because it represents the best result so far.

Step4: Here the transfer of tables that are set in step 2, which keeps the hard constraints. Each table mode, the seeking mode , otherwise apply it to the tracing mode process. The process steps are presented above.

Step5: This step you select the number of tables that have been filtered in step 4, And put it into the tracing mode according to MR, and the others set into seeking mode. Step6 Check the status of completion, if have been achieved, ending the program, otherwise, refer to Step 3. This is shown in figure 4.

Cat Swarm Optimization

```
<?
$n=rand();
$table=initialize($n);
$cycle=1;
do
$best=evaluate($table);
$check=$table($cycle);
if(seeking($check))
process_seeking($check);
else
tracing($best);
$cycle=$cycle+1;
while($cycle<$n);
?>
```

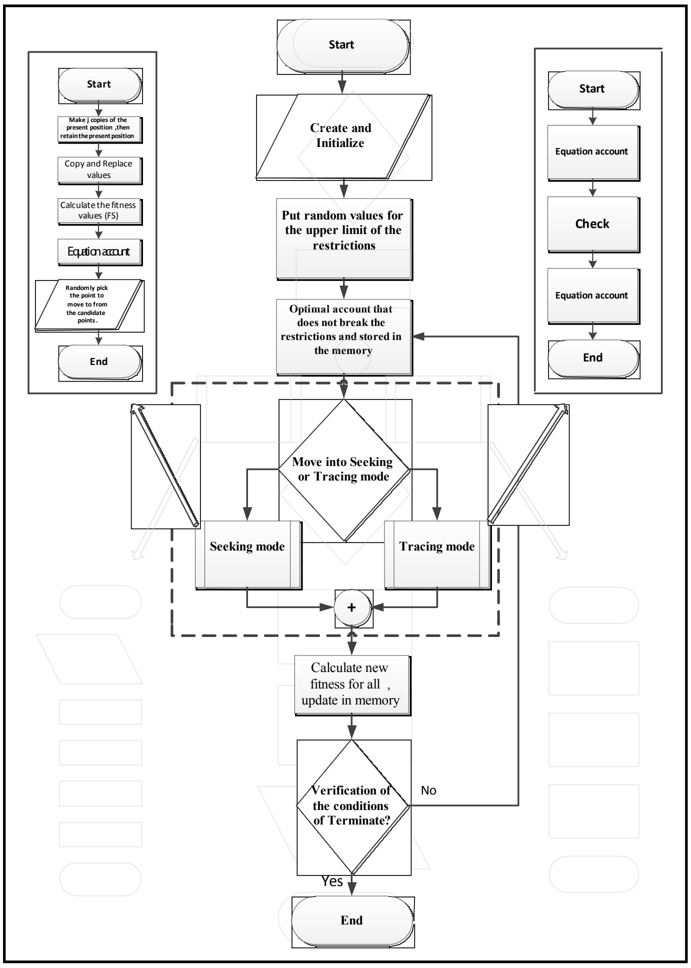

Fig. 4 : The CSO Flowchart

VIII. Experiments and Results

CSO algorithm is programmed in PHP Information Version 5.2.6 under
Windows 7 Ultimate.
For the purpose of ascertaining the efficiency of the proposed system it has been proposed to apply the real data of the Department of Mathematics algorithm, According to the following data we repeated the experiment on this data three times according to the following data:

A. The first experiment:

Table 1 : The condition of the first experiment

Numberof Courses	Numberof teachers	Number of classrooms	Number of days	Number of hours
19	15	6	5	6

Table 2 : The obtained results to in the first experiment

	The ideal solution	Number of Solutions	Seeking Mode	Tracing Mode	The number of iteration
1	3	1	30.12%	69.88%	10041
2	3	1	20.43%	79.57%	3548
3	2	1	17.89%	82.11%	2120

B. The second experiment

Table 3 : The condition of the second experiment

Number of Courses	Number of teachers	Number of classrooms	Number of days	Number of hours
40	26	5	5	6

Table 4 : The obtained results to in the second experiment

	The ideal solution	Number of Solutions	Seeking Mode	Tracing Mode	The number of iteration
1	4	2	37.22%	62.78%	16293
2	4	2	25.58%	74.42%	11012
3	3	2	20.39%	79.61%	2120

IX. Conclusion and Future Works

A. Conclusion

Considered to schedule appointments undergraduate courses of the most complex issues, and the reason is that it requires to meet the restrictions and these restrictions are considered the foundation stone in the construction schedule deadlines.
And so it was used swarm optimization algorithm cat because she characterized by flexibility in dealing with these issues, so try to get the best result, and characterized by high efficiency of the proposed algorithm in the process of creating schedules appointments without exceeding the restrictions.
The proposed technique can be applied to other college departments, and then circulated to the rest of the faculties of the university. And it can be applied to the whole college, and in this case you must use a high-tech device in processing speed, which depends on the style of parallel processing , in the absence of such devices, particularly in developing countries could be in the implementation of cloud computing environment.

B. Future Works

You can use this study as a reference for researchers to take advantage of the results and the application of the algorithm on other topics, including Transportation Timetabling, Employee Timetabling, Sports Timetabling.
- This study agreed with previous studies [5, 26] which has specialized in the calculation of the efficiency of the algorithm and treatment when compared with their counterparts from other algorithms Squadron.

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