Research on Model of Course Scheduling System for Ideological and Political Teaching in Colleges and Universities Based on Particle Swarm Optimization

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Abstract

Currently, the course scheduling of ideological and political course in colleges and universities is always constrained to a certain extent. Also, the problem with regard to combination and optimization of courses with other major courses is the key point to teaching hours unable to be arranged appropriately. Owing to the search efficiency of genetic algorithm or other course scheduling model is low when solving this problem, this study presents a kind of course scheduling algorithm based on particle swarm optimization (PSO) and designs a model of course scheduling system for ideological and political teaching in colleges and universities based on this algorithm. In consideration of the conflict situations such as time, space resources, teacher resources and others may arise out of the course scheduling, the effective distribution based on particle swarm optimization is performed so that the maximum utilization of time and space as well as teacher resources can be achieved. The design of course scheduling system can be attained based on particle swarm optimization by programming language and the effectiveness and availability of system are examined by experiments and test results.

Keywords: Particle swarm optimization (PSO), Iterative operation, Function model, Course scheduling system, Experimental results.

1. RESEARCH BACKGROUND

1.1 Literature overview

There is a higher demand for course scheduling system in colleges and universities teaching. Many problems of course arrangement such as teachers, students, classes, major courses and other information matched can be settled by employing course scheduling system. The ultimate target of teaching arrangement system is to optimize the finite teaching hours and classes, as well as teacher resources (Li and Liu, 2015). When these three elements are in a state of uniform balance, the teaching contents can be regarded as being scheduled effectively and reasonably (Feng and Yang, 2013). In the past, many theoretical models of teaching arrangement were employed in our colleges and universities, such as genetic algorithm, greedy algorithm, back-track algorithm, ant colony algorithm, simulated annealing algorithm, graph coloring algorithm, etc. (Li and Li, 2013). Although each course scheduling algorithm has its own advantage, the optimal arrangement scheme has not been put forward yet. Thus, the optimal distribution model aimed at course scheduling system still needs to be further studies.

1.2 Research purpose

In the past applications of teaching scheduling system models, although most of courses scheduled can be optimized, the final optimal effect of teaching arrangement aimed at ideological and political course is still difficult to be achieved all along, owing to the special needs of the ideological and political course (Wang and Yao, 2013). On the one hand, the teaching hours of the ideological and political course are relatively tight and the teachers for this course are less. On the other hand, the ideological and political course is attributable to general course in colleges and universities of our country and all students on campus have to attend class in an enlarged class mode (Cao et al., 2012). Based on the above-mentioned two factors, the ideological and political course in colleges and universities should meet the requirements of teaching arrangement for all teachers and students on campus through a more rigorous course scheduling system. For this reason, this study designs a brand-new model
of course scheduling system for ideological and political teaching in colleges and universities based on the theoretical framework of particle swarm optimization so that the overriding target of optimal distribution for ideological and political courses can be achieved.

2. PSO OVERVIEW

2.1 The advantage of PSO application in course scheduling system of ideological and political teaching

Particle swarm optimization, also called bird flock foraging algorithm, abbreviated to PSO, is a random search algorithm based on mass collaboration and is developed by mimicking the foraging behavior of birds flocking. At present, the academics universally believe that this algorithm is an extension of swarm intelligence and can be incorporated into multi-agent optimization system to be operated and developed (Long and Xu, 2012). PSO algorithm pertains to evolutionary algorithm in form and is more similar to simulated annealing algorithm in that both operation mechanisms are the operational models of random solution set, at the same time, the operational target can be reached by iterative optimization method. Then, the quality of solution set is evaluated objectively by fitness of operation results. Compared with course scheduling of genetic algorithm, the PSO algorithm is simpler and there is no need to carry out crossover or mutation operation. Therefore, it is more suitable for practical arrangement of ideological and political teaching with high applicability and is no need to spend more computing time. Also, PSO algorithm can search global optimal distribution according to and following the current optimal value that has been found (Lan et al, 2014). This operation result is the optimal scheme ratio of the teaching hours of ideological and political courses in colleges and universities to all teachers and students on campus. So the convenience, high precision, fast convergence and other advantages of PSO algorithm can support the operation efficiency and effect of course scheduling system for ideological and political courses in colleges and universities.

2.2 The theoretical model of particle swarm optimization

Particle swarm optimization (PSO) is a simplified simulation for simulating social behaviors, as a stylized representation of the movement of organisms in nature. Its simple collective behavior can be modeled by several simple rules, such as fish school, bird flock and others. It simulates the habit of organisms searching food randomly and finds the optimal scheme or mode with the shortest distance in the same area, and then, in information share mechanism, the objective judgment for the current environment can be formed (Wang and Ye, 2012). In that way, the food can be searched in swarm in best position and speed. That is the operation principle of theoretical model of PSO. Each optimal solution set in particle swarm is equivalent to the “bird” in the search-space, which can be used to represent the particle, while the “food” represents the optimum solution. Meanwhile, each independent particle corresponds to the fitness value decided by problem that is to be optimized, and then the degree of optimization of this particle is valued so that the optional mode of this particle in moving distance and direction can be determined, also, the optimal movement mechanism and mode can be judged by own experience of the particle.

3. THE OPERATION MODE OF COURSE PLANNING BASED ON PSO

3.1 PSO function model

In particle swarm optimization, multiple particles as the analysis variable in swarm space need to be selected first, and then the search for individual particle is performed (Zhou and Hou, 2011). When the historical position in swarm is fully considered, the optimal space target of this particle is also taken as reference and its change regulation is studied.

The space position of No. i particle can be expressed as: \( \vec{y}_i = (y_{i1}, y_{i2}, ..., y_{iD}) \)

The individual velocity of No. i particle can be expressed as:

\[
\vec{v}_i = (v_{i1}, v_{i2}, ..., v_{iD}) \quad (1 \leq i \leq m, 1 \leq d \leq D)
\]

The best historical position of No. i particle in its space displacement can be expressed as:
\[ \tilde{Q}_i = (q_{i1}, q_{i2}, \ldots, q_{id}) \]

After the best position selected by No. \(i\) particle is recorded, it should be marked as:

\[ \tilde{Q}_g = (q_{g1}, q_{g2}, \ldots, q_{gd}) \]

The operation model for relation between velocity variable and position of No. \(i\) particle is:

\[
V^{k}_{\text{id}} = V^{k}_{\text{id}} + C_1 \lambda (Q^{k}_{\text{id}} - Y^{k}_{\text{id}}) + C_2 \lambda (Q^{k}_{\text{gd}} - Y^{k}_{\text{id}}) \\
Y^{k+1}_{\text{id}} = Y^{k}_{\text{id}} + V^{k+1}_{\text{id}}
\]  

(1)

(2)

In the above formula, \((C_1, C_2)\) can be considered as positive constant of learning factor. Learning factor is the learning ability of individual particle that has a tendency to summarize self-experience in function model of PSO. Thus, in the process that particle selects the best solution path, it is also restricted and influenced by learning ability factor at the same time (Zhang et al, 2011). When the best historical approach points is searching from inside to outside of swarm, this learning ability is particularly important. Under the condition that \((\lambda, \lambda) \in U[0,1]\), its valued space presents distribution characteristics of pseudo-random number. The velocity of particle can be limited to the range of optimal path and is marked as: \(V_{\text{max}}\).

3.2 The derivation process for the best historical position of particle

![Figure 1. A Graphical Representation of the Optimal Location Of Particle History](attachment:image)

When all particles are compared with their neighborhood members, the optimal solution set of particle swarm will be presented in global version. Or when particles take position as optimal optional mechanism, the relative local optimization form will be presented. The optimization algorithm of particle swarm can be defined as theoretical model of topology structure and its calculation process can be described by three steps. First, the initialization operation aimed at random particle is carried out within initialization category, as well as including velocity and space position of particle. And the individual adaptive value of individual particle is calculated, and then record and statistics is given (Wu and Jiang, 2010). After that, the adaptive value of individual particle is judged and
compared by optimal historical position, taking the optimal state of each particle in historical position as recording point and aiming at fitness value of its position to evaluate so as to constrain the effect of global position. Finally, according to Formula 1 and Formula 2, the relation between variable velocity and position of particle can be calculated, and alternation and update for old position and new position are carried out so that the fitness value and optimal solution of the best scheme can be obtained by iterated algorithm. Through three processes, the best solution scheme of particle swarm can be achieved and the feasibility of planning scheme for ideological and political course can be objectively depicted by operation result. The flow mind map is shown as Figure 1.

4. DESIGN SCHEME OF COURSE SCHEDULING SYSTEM BASED ON PSO

PSO algorithm applied in course scheduling system of ideological and political teaching in colleges and universities can improve the optimization effect of course arrangement. The course scheduling system can be divided into four main modules: information maintenance, curriculum creation, curriculum inquiry and system management. The framework structure is shown in Figure 2.

![Figure 2. Framework Structure of the Class System Based on Particle Swarm Algorithm](image)

4.1 Function module of information maintenance

In information maintenance, course scheduling system based on PSO algorithm carries out retrieval and update with regard to teaching plan and classroom information mainly so as to guarantee that there is no conflict occurred in course scheduling process at later stage. In the limited time available, the ideological and political course should meet two conditions: first, teaching task must be completed on time. That is to say, the time arrangement for teaching content must comply with overall time of students on campus (Yu et al, 2010). Second, teaching information also needs to be adjusted appropriately. Owing to the conflict between optional courses and major courses of some teachers in daily teaching, the random adjustment is indispensable. So the real-time update of teachers’ information is an important part in function module of information maintenance. And the real-time update of classrooms is a guarantee that there is no conflict between the ideological and political courses and other courses as well. Moreover, it is necessary to ensure that course information is matched with classroom arrangement in order to attain the specific requirement that the courses have been scheduled precisely.

4.2 Function module of curriculum creation

In function module of curriculum creation, there are two aspects mainly- manual creation and automatic creation. On the one hand, manual creation refers to that, in case the schedule of ideological and political course needs to be adjusted in a timely manner or one lesson has to be cancelled, the function that the course in curriculum can be added or deleted manually in this system should be equipped with. On the other hand, the automatic creation should be taken as the core in the process of supplementary curriculum created manually (Yu et al, 2012). The basic principle of automatic creation is the important basic condition that guarantees three essential factors: teachers of ideological and political course, classrooms and students to be matched timely. In addition, the automatically created curriculum in this system is classified as teacher curriculum and student curriculum. Through two curriculums, the timetables of students and teacher can be clearly identified so that students and teachers can better understand teaching task and learning task of their own at the first time.

4.3 Function module of curriculum inquiry
The curriculum inquiry is the core function of this system in which class curriculum inquiry and classroom curriculum are mainly included. The function of class curriculum inquiry is the time guide of ideological and political teaching that is created automatically and is marked with course location and teacher’s name at the same time after students input their own class numbers. If the course information in the function module of curriculum creation has been changed by teachers, the result of change can be attached to inquiry function and prompt students to pay attention. And the inquiry function of classroom timetable is specially established for teachers of ideological and political course (Yu et al., 2015). In daily teaching, the ideological and political course also includes the theory course, the multimedia course and the computer operation course. Thus, the arrangement of teachers is related to regular classroom, multimedia classroom and computer room. Before class, the teacher of ideological and political course should inquire whether there is any multimedia classroom or computer room that is not occupied in accordance with the specific needs of this lesson so as to confirm that the course in this regard can be smoothly carried out with the aid of computer technology. Therefore, in the ideological and political teaching activities in colleges and universities, the function of curriculum inquiry is based on the purpose that both students and teacher are able to use, as well as presenting path for technical indexes of different operation modes. For this reason, this study sets the function module of curriculum inquiry as two important differential functions- class and classroom.

4.4 Function module of system management

There are two functions- user right management and system information assistance in function module of system management mainly. On the one hand, the user right management is mainly to lock two major targeted groups that use this system, which are teachers and students. The main settings for students right are content query and check of curriculum. When students receive new curriculum, they should check their update situations about course information after login authentication (Mei and Xu, 2016). While teachers’ right is mainly to clearly understand that the teaching hours are matched with courses. When ideological and political course is replaced by other course, the adjustment can be operated only after the right has been locked so as to ensure the rationality and timeliness of the adjusted course. On the other hand, in the function of system information assistance, the index of curriculum inquiry function, as well as the setting of system functions and the guidance of memorandum and other functions, needs to be designed. The introduction and prompt of main functions serve the new users, while the prompt function of changed information is for the old users. Thus, it can be guaranteed that all user groups are able to enjoy the functional guidance when applying curriculum system and then the outputs of multiple functions can be matched in real time so that the efficient use of this system can be improved.

5. THE EFFECT ANALYSIS OF IDEOLOGICAL AND POLITICAL COURSE SCHEDULING UNDER PSO ALGORITHM

5.1 Cardinal statistics of course scheduling

<table>
<thead>
<tr>
<th>Teaching class</th>
<th>Number of people</th>
<th>Theory class hours</th>
<th>Practice periods</th>
<th>Multimedia time</th>
</tr>
</thead>
<tbody>
<tr>
<td>The class of 2015 students</td>
<td>127</td>
<td>8</td>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>The class of 2016 students</td>
<td>119</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>The class of 2017 students</td>
<td>126</td>
<td>4</td>
<td>12</td>
<td>5</td>
</tr>
</tbody>
</table>

The optimal scheduling of the ideological and political course in colleges and universities can, after course scheduling system designed by this study is adopted, be provided with more rationality so that the teaching time can be matched with teachers effectively. The error rate of artificial calculation can be reduced in the application, and the sequence and efficiency of course scheduling can be greatly improved. In addition, when some teacher proposes to change course location or course time temporarily, it can carry out comparison between the teachers’ needs and students’ schedule so as to find out the related information and methods fit to course change. This study takes the ideological and political course arrangement of students in three majors at this school as the example to carry out the curriculum planning, as shown in Table 1.

5.2 Experimental environment

Hardware environment: Intel Celeron D 3302.66G/1 G RAM, the operating system is Microsoft WindowsXP Professional. In the experiment of ideological and political teaching, the population size is set as 20. The
parameters of PSO algorithm are: $C_1=0.1$, $C_2=0.1$, $C_3=0.8$. The number of iterations are 3000. The probabilities of crossover and mutation of genetic algorithm are $P_c=0.7$, $P_m=0.1$ relatively, compared with the results of genetic algorithm, the average result of 50 run results is taken as measurement result and related values are obtained as shown in Table 2.

<table>
<thead>
<tr>
<th>Method</th>
<th>Population size</th>
<th>Optimal fitness value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional class scheduling</td>
<td>20</td>
<td>1220</td>
</tr>
<tr>
<td>PSO</td>
<td>20</td>
<td>1560</td>
</tr>
<tr>
<td>Traditional class scheduling</td>
<td>30</td>
<td>1170</td>
</tr>
<tr>
<td>PSO</td>
<td>30</td>
<td>1430</td>
</tr>
<tr>
<td>Traditional class scheduling</td>
<td>40</td>
<td>1080</td>
</tr>
<tr>
<td>PSO</td>
<td>40</td>
<td>1390</td>
</tr>
<tr>
<td>Traditional class scheduling</td>
<td>50</td>
<td>960</td>
</tr>
<tr>
<td>PSO</td>
<td>50</td>
<td>1270</td>
</tr>
</tbody>
</table>

It can be found in this table that the fitness of optimal optimization provided by traditional course scheduling mode is poor, while the new course scheduling system based on PSO algorithm can provide more optimization methods and then improve the timeliness of teaching time arrangement of ideological and political course in colleges and universities so that the best proportion of teaching time, class and teaching hours can be achieved.

6. CONCLUSION

To sum up, multiple variables such as students, teachers, courses, classrooms and others should be considered as specific evaluation criterias with regard to teaching time arrangement of ideological and political course in colleges and universities. The design of course scheduling system applying PSO algorithm is the optimization design direction based on balance distribution with above-mentioned multiple factors as the target. The course scheduling system designed by this study based on PSO algorithm is provided with four important functions: information maintenance, curriculum creation, curriculum inquiry and system management. It can be seen that, compared with traditional course scheduling mode, the efficiency of course scheduling has been greatly improved, the advantage of teaching time concerned with ideological and political course, as well as the effect of timely course scheduling after the curriculum adjusted, can be effectively analyzed. Therefore, it can be proved that PSO algorithm as the core algorithm of course scheduling system is with high application and application value, can assist the reasonable planning of ideological and political course in colleges and universities and then acquire the expected matched teaching schedule so that the ideological and political course and related courses can be scheduled reasonably and the maximum utilization rate of teaching time and space can be obtained.

ACKNOWLEDGEMENTS

2017 annual National Youth League research project (Key Issues): the reform and innovation of university volunteer service under the background of government purchase service: taking the universities of Wuhan as an example. The number of the subject: 2017ZD120.

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