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The Comparison Between Lofti-Cerveny-Weitz Method and Local Search Genetic Algorithm for Completion of Maximally Diverse Grouping Problem

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Key words: Maximally diverse grouping problem, Lofti-Cerveny-Weitz method local search, Genetic algorithm

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Abstract: Maximally Diverse Grouping Problem (MDGP) consists of grouping a set of M elements into G groups. The diversity of the elements in each group is maximized. The MDGP problem is one of the most complex computational problems today. It is the NP-Hard Problem. The Lofti-Cerveny-Weitz (LCW) method is a variation of the Lofti-Cerveny (LC) method. It explains that the search for element j is not limited to group g. LCW considers all groups when searching for j element except element i is located. Genetic algorithm is an intelligent optimization technique based on simulations of biological evolution. ZP Fan explains GA-based heuristic steps combined with Local Search for MDGP. The MDGP case of this study is at the ITERA dormitory. It divided into several attributes. They are regional origin, study programs, economics, religion and academic skills. Moreover, they were classified into groups and every group consisted of four students. Fitness value is calculated by adding up all the distance of students in each group. Student distance is obtained by using the Euclidian distance formula at the distance of the five student attributes. The result of this study showed that the fitness value using the Lorent-Cerveny-Weitz method was higher than the local search Genetic algorithm. It explained that male dormitory were 0.0066 and 0.0011% for female dormitory. The computation time of Lorent-Cerveny-Weitz Method was longer than the local search Genetic algorithm. It explained that male dormitory were 684 and 660% for female dormitory in longer duration.

INTRODUCTION

In this study, it is reported how to divide the elements into groups to create maximum diversity. This is called the Maximum Diversified Grouping Problem (MDGP). The MDGP problem is one of today's complex computational problems. ZP Fan in his journal[1], developed a hybrid algorithm based on Genetic Algorithms for grouping problems that had been developed by Falkenauer[2], integrated Genetic

algorithms with local search which the results show an increase in computational performance. Feo and Khellaf proved that the Maximally Diverse Grouping Problem (MDGP) is a NP-Hard Problem[3].

Several researchers have conducted the research to complete MDGP by using the heuristic method. They are Weitz and Jelassi[4], Weitz and Lakshminarayanan[5-6], Feo *et al*.[7], Lotf and Cerveny[8], Arani and Lotf[9] and Baker and Benn[10]. Weitz and Lakshminarayanan compared the five heuristic methods and concluded that the Lotfi-Cerveny-Weitz (LCW) method was developed by Weitz and Lakshminarayanan based on an algorithm who written by Lotf and Cerveny is the best method.

MATERIALS AND METHODS

Fitness value calculation: The calculation of the fitness value was to calculate quantitatively how proper a solution works to solve the problem. A better solution will get a higher fitness value. The fitness value calculation function evaluated how close the solution to the optimum solution of the problem to calculate the value of fitness depended on the problem. Each problem had its own fitness value calculation. The fitness values must be clearly defined, so that, readers were able to understand how fitness values were obtained. The use of fitness values must also be consistent, it was not able to be changed in the process of solving problems.

The Institute of Technology Sumatra (ITERA) is a state university. It is located in Lampung Province. In 2018, ITERA had a dormitory that is able to accommodate 305 male students and 460 female students. The rooms division is conducted by the provisions in one room consists of four people. It is created to consist of divide the origin, study programs, economic groups, religion and different academic abilities.

In this study, there was a group of students who is able to be divided into rooms in the dormitory. Each room was filled by 4 students. Grouping was conducted in order to get high diversity of students. Students were divided based on five attributes of the students. They were regional origin, study programs, economic ability, religion and academic values. Students who came from the nearest area meant that the attribute of distance was small, the farthest which consisted two cities had the greater of attribute distance. This was made because the nearest cities usually still had the similar customs whereas the farthest cities usually had far different customs. To calculate the distance from the origin attribute, a distance table was made between cities.

The diversity value of students also calculated the attributes of study programs and religion. When the study program was same, it meant that the attribute distance was 0. In contrary, point 1 was made by the study program which had the attribute distance gets the maximum value. Similarly, if students are different religion then the attribute distance was 0 for the religious attributes. Moreover, point 1 was made by the study program which had the attribute religion diversity.

Each ITERA student was divided into 8 groups based on their economic ability to determine the single tuition Fee. They are group 1-8. Besides, there was also group 0 for low income students and families which grouped outside the single tuition fee group because students who receive scholarships did not pay the single tuition fee. This single tuition fee group and scholarship recipient were able to be used as an attribute of economic capability in this study.

Finally, an attribute of academic value the National Exam scores were used. This value was considered by the researcher to reflect the academic ability of students who were used to classify students for the division of dorm rooms. The distance for each attribute must be normalized. This process used the attribute values in the same range of values. In this study, the authors used a range of values from 0 to 1 for all attributes

Implementation of the Lofty-Cerveny-Weitz method: To increase the value of fitness, LCW searched for all of i elements in M, LCW searched for element j that can exchange with element i which increased the value of fitness. LCW considered all groups when searching for element j except for the group where element i was located. The steps of the Lofty-Cerveny-Weitz method in this case study were able to be described as follows:

The first step in resolving the problem of students group for the division of dorm rooms using the Lofty-Cerveny-Weitz method was to create an initial solution. A random solution was able to be used as an initial solution. The process of making a random solution was able to be described as follows:

It made the initial solution within the maximum solution and calculation of the initial solution fitness value within the maximum solution fitness value. Then, the iteration was added to the fitness value. Each iteration created 0 switch variable value.

In each iteration, each student was assumed to exchange groups with all students and they are not in one group. Each of these presupposition would produce a solution. If the value of the fitness of the presupposition solution was greater than the maximum value of the current solution, then the presupposition solution was used as the maximum solution and the value of the supposition solution was the value of the maximum solution fitness. Every time the supposing solution was made as a maximum solution the switch variable was added by 1.

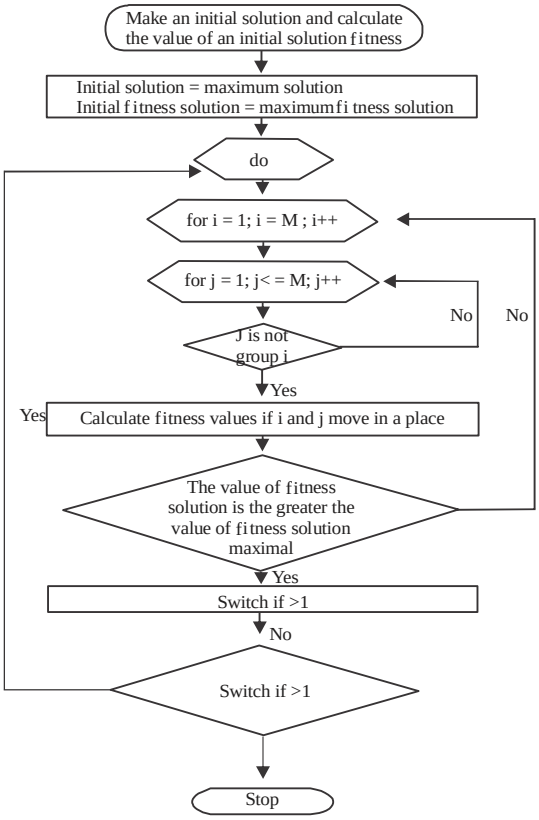

Fig. 1: The flowchart of Lorents-Cerveny-Weitz method

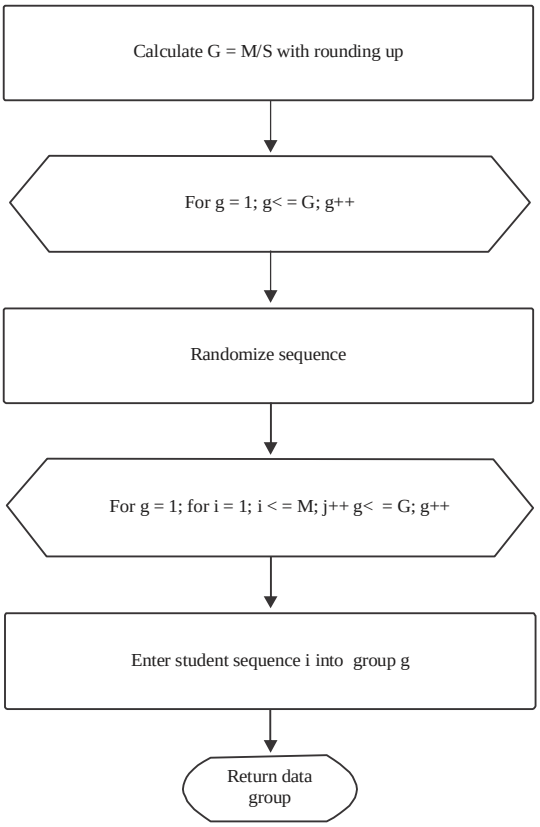

Fig. 2: Flowchart of random solution construction

One iteration had been completed if each student had finished presumably exchanging groups with all other students who were not in group. If the value of the switch variable was >0, then it repeated the iteration process. It would be conducted until the switch value was 0. After the iteration process of adding the fitness value was complete, the final maximum solution was the final solution from the Lofty-Cerveny-Method (Fig. 1).

Implementation of local search genetic algorithms: The steps of the local search Genetic algorithm in this study can be described as follows, the easiest stopping criteria for GA is number of generations (iteration). If the number of generations is low, the probability of finding the best results is also low. And if the number of generations is too high, it will cause too long processing time. In the local search Genetic algorithm, g_LS is the number of LS iterations and g_GA is the number of GA iterations. Fan *et al*[1]. experimented and found that the best value can be obtained with g_LS = 1 and g_GA = 30. This study uses the same g_LS and g_GA values as Fan *et al*.[1] (Fig. 2).

Local search on our MDGP is a recurring procedure. In each iteration, the procedure scans all neighboring solutions and selects the best to replace the current solution. A neighboring solution is obtained by swapping two elements from different groups from the current solution. This procedure is also described as a repair procedure by Baker and Powell[10]. LS for MDGP can be seen in procedure (Fig. 3):

Local search procedure
for (i = 1 to M)
χ is a collection of elements that different groups with pi
Δ ti is an objective function change by replacing pi danpt,
where pt $\in \chi$
find _ti^max=max { _ti $|\rho$_t$\in$c}
if _ti^max>0
change pt change pi
end
end

Testing phase: Compared things of this study were the fitness value and the processing time of each method/algorithm. The device used the DELL Inspiron 3670 brand computer with a RAM specification of 12 GB an Intel Core I7 3.20 GHz processor. The test was divided into two parts. They used 305 male dormitory data and 460 female dormitory data. The grouping both male and female dormitory was done using the LCW and AGPL methods, each of them was conducted in 3 times.

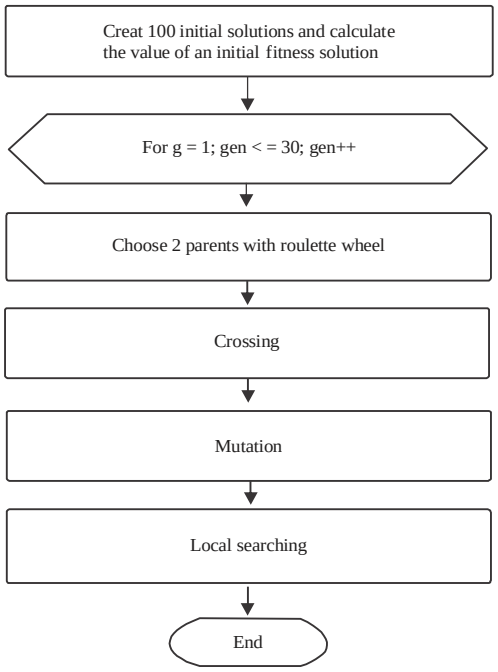

Fig. 3: Flowchart of Lorents-Cerveny-Weitz method

RESULTS AND DISCUSSION

Figure 4 explained that capture screen on the application for conducting the research, the result on the student group between male dorm and female dorm was explained into Table 1. From the results explained that the Lorent-Cerveny-Weitz method and the local search Genetic algorithm were able to solve the problem of grouping with maximum diversity to divide into student rooms, each containing a maximum of 4 students in the Institute of Technology Sumatra dormitory. The fitness value explained that the grouping results using the Lorent-Cerveny-Weitz method was higher than the results of grouping with the local search Genetic algorithm. They were 0.0066% for male dormitory and 0.0011% for female dormitory. Even though the fitness value obtained by the Lorent-Cerveny-Weitz Method was higher, the computation time of the grouping process using the Lorent-Cerveny-Weitz Method was longer than the results of grouping with the local search Genetic algorithm. They were 684% for longer duration in male dormitory and 660% for longer duration for female dormitories (Table 1).

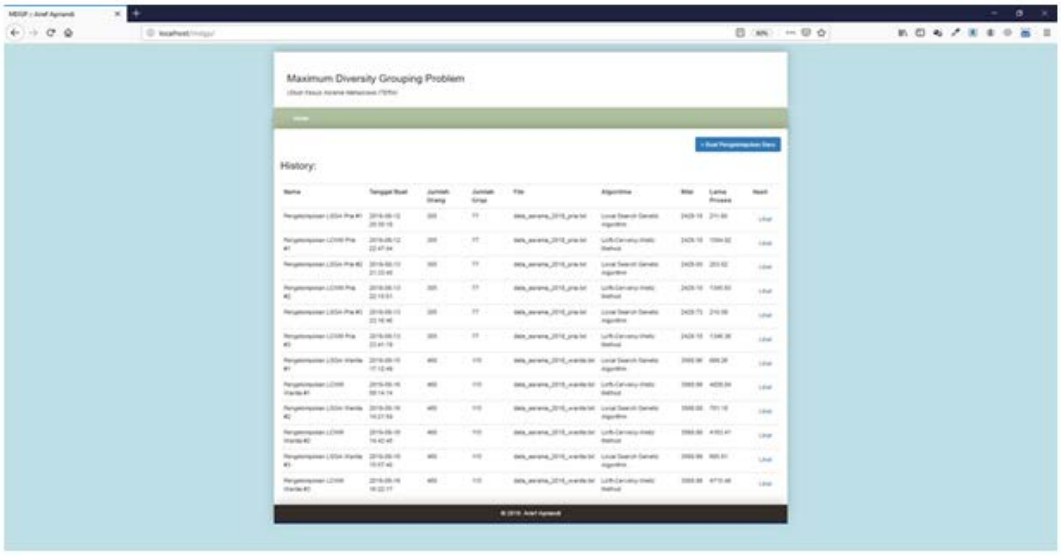

Fig. 4: Screenshot of experimental results

Table 1: Comparison of LCWM and LSGA test result

		Male dorn		Female dorn	
Trail	Note	LCWM	LSGA	LCWM	LSGA
1	Fitness value/time process	2.429,10/1.584,82	2.49,10/211,80	3.568,98/4.828,84	3.568,96/689,26
2	Fitness value/time process	2.429,10/1.45,10	101,21/203,62	3.568,98/4.163,41	3.568,88/701,18
3	Fitness value/time process	2.429,10/1.346,36	2.428,73/210,09	3.568,98/4.715,46	3.568,98/685,.61
Average	Fitness value/time process	2.429,10/1.425,43	2.428,94/208,50	3.568,98/4.569,24	3.568,94/692,02

CONCLUSION

The Lorent-Cerveny-Weitz method and the local search Genetic algorithm are able to solve the problem of grouping in maximum diversity at the ITERA dormitory. The suitability value explains that the results of grouping using the Lorent-Cerveny-Weitz method are higher than the results of grouping with the local search genetic algorithm. Although, the conformity value obtained by the Lorent-Cerveny-Weitz method is higher, the computation time of the grouping process using the Lorent-Cerveny-Weitz method is longer than the results of grouping with the local search Genetic algorithm.

RECOMMENDATION

This research can be given for the development to better research. It will add other attributes such as the level of English mastery, the level of computer mastery. It also compares with other newer algorithms such as skewed general variable neighborhood search and taboo search with strategic oscillation. Combining methods, it will acquire the better algorithm that requires faster computing time or produce a solution with a higher fitness value.

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