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Introduce a Solution for Optimizing Interactive Genetic Algorithm to Increase Productivity

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Abstract. The Unequal Area Facility Layout Problem (UA-FLP) made using different methods to measure the quantity used. The plant features UA-FLP enhance productivity and can reduce between "20%" to "50%" of total operating costs. In this regard, an Interactive Genetic Algorithm (IGA) is presented that allows the Decision Maker (DM) to interact with the algorithm. In this method, the DM is to find the best and most appropriate solution. DM to avoid overloading, population classified into clusters and each cluster represents only one element is evaluated directly by the DM. But the problem is that the DM process to achieve the best result must pass many generations and it causes high exhaustion DM. The algorithm presented in this paper will reduce the wear on the DM. A memory of the best solutions chosen by the DM is kept as a reference. An interactive genetic algorithm is presented able to take advantage of the DM.

Keywords: Component; interactive genetic algorithm; optimization; evolutionary computation; decision maker; UA-FLP.

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1. Introduction

UA- FLP is important for save on production. Because affects directly on the cost of production, Work time, work processes and efficiency. There are many kinds of layout problems by (Wang, 2010) and (Aiello, 2006) and other researchers have investigated. This paper focuses on the UA-FLP so that it can provide a model increased the efficiency. Most researchers have investigated material handling cost and closeness or distance relationships as the problem of the using quantitative performance. In this respect, the qualitative features should be considered include primacy about the special features, the distribution of the remaining space, location of features or any inner consideration that can be important for DM. Survey of these qualitative features by the classical heuristics or meta-heuristic optimization method is very complex for DM. Quality features include: subjective, not known at the beginning or change during the process. DM participation in quality considerations is necessary in plan. In addition, involvement the DM in process has additional advantages including: expert knowledge, Choose the best solution, but not necessarily an optimal solution, surveying when there is a conflict between objectives and limitations. Help to Algorithm to lead the search process, stimulating the creativity of the user, and obtain real solutions, innovative and enforceable.

Some Evolutionary Computation (EC) uses the UA-FLP. The use of the genetic algorithms is also common. (Garcia, 2013) believes that the interaction between evolutionary algorithms can greatly improve the optimization design by involving users for a satisfactory search solution. These interactions lead to greater use of qualitative considerations. In IEC, the fitness function is based on a human evaluation. In this paper, we discuss an interactive genetic algorithm to handle the UA-FLP. And requires the intervention of a DM to specify a satisfactory solution. This approach allows the DM to interact with the algorithm to lead the search process.

2. Literature Review

UA-FLP is a rectangular plant with fixed dimensions (W H), and in-

cludes a set of features. As you can see in Formula 1 for each of them an (Ai) is the requirement that all regions features should be less than or equal to the Plant Area. The objective is to placing the features for optimizing the criteria features.

$$\sum_{i}^{n} A_i \leqslant W \times H \qquad (1)$$

For the showing the plant layout the Flexible Bay Structure (FBS) that has been proposed by Tong and considered by many researcher, is used. Confine plant layout is defined by the dimensions of height and width. The rectangular plant in a direction is divided into bays of different widths, then each bay in order to place the facility into its component parts that make the main plan. Bays width is flexible and compared to inside features can be changed. The first example displays structure of a flexible bay. The issue of unequal area features in UA-FLP involves many problems. Recently the work on genetic algorithms to find optimal solutions to problems UA-FLP system has proved. The main topic of this method related to encoding genetic and evolutionary mechanisms of implementation that should allow to discovery of a large sample space to feasibility the solutions and ensure it going to improve. In addition, in the real conditions which issues of diversity initiatives. Should be considered the problem is bigger than the issue of multi-objective optimization. FLP are using too simple optimization techniques that finally will effect on quality of the obtained solutions and performance of the optimization methods.

Sometimes to keep quality and quantity of UA-FLP system a multi-objective function with a multi-criteria DM is used that it is known as multi-criteria optimization. This process method is as follows that Parto optimal solutions by performing the genetic algorithm perform 4 fitness function inside the evolutionary method, then the overall Structure outside the control of genetic algorithms ranked and then the optimal solution is selected that this work is done using a multi-criteria decision. This method allows the DM to express his preferences that the efficacy of this approach has also been approved. The main advantages

with respect to existing approaches for example: bay structure, is the search space is significantly wider and practical plan arrangement has been kept, thereby improve the quality of solutions obtained. (Aiello, 2012)

3. Interactive Genetic Algorithm

In this section the features of interactive genetic algorithm for solving UA-FLP, including qualitative aspects are discussed.

Ant colony optimizations

An ant colony optimization is an algorithm that has shown good results in solving many optimization problems. This research can be extended in many areas and also for research improvement on problems that have empty space would be very interesting. This algorithm uses slicing tree representation to easily represent the problems without too restricting the solution space and it uses several types of local search to improve its search performance and is quite robust and has improved several problems. It performs better than GA with ?exible bay representation which was proposed by (Tate and Smith, 1995). This algorithm yields good results when there is no empty space in the facility (area utilization equals to one). This research can be extended in many ways. It will be interesting to improve this research on problems which have empty space. (Yew Wong and et al., 2010)

An ant system algorithm can solve UA-FLP with FBS presented. In additionally the FBS representation improvements is made that solve problems with empty spaces. This algorithm can improve the best known solution to several problems. Finally, The FBS representation can be improved with the use of empty space. (Yew Wong and et al., 2010)

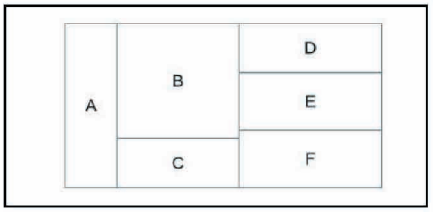

Figure 1. Flexible bay structure representation [1]

Encoding structure

The genetic algorithm does not work on parameters or variables, but also deals with the version of the code. One of the methods to code is binary code, which the goal is to transform the answer to a series of binary numbers. Each individual of the population has a coding structure that consists of three parts. One of the three is genotypes which use to encrypt the plant layout, the chromosome used is inspired from that proposed by Gomez et al. (Gomez et al., 2003) and is made up of two segments. The first segment represents the facility sequence, which is read bay by bay, from left to right and from top to bottom and is a permutation of n labels, that n is the total number of facilities in the plant layout. The second segment contains essential information about the bay divisions in the plant layout, which are consists of (n-1) binary elements. When the value in second segment is 1, the facility occupying the same position in the first segment is the last element of the bay.

Evaluation

Fitness function is gain from right convert on goal function, it mean the function that is optimized for. This function evaluates the quality of each string with a numeric value that specifies quality. Whatever the quality of the solution string is higher, the fitness value of the solution would be more and the probability of transfer to the next generation will be increased. Evaluation is made by the DM and therefore is completely subjective. In order to avoid fatigue DM, only a representative subset of the sufficiently different solutions from the population is presented from human evaluation.

Clustering algorithm

Because of the number and complexity of the features that defines the UA-FLP individuals, each element can belong to more than one cluster simultaneously. In this method, inherited evaluations can be received over a representative element And also the algorithm to adjust the evaluations of the elements that are near the bounds of the cluster accurately. To responding to these needs, we can use the clustering share method along the previous method.

Steps in an interactive genetic algorithm

IGA process is shown in diagram "Fig. 2"and explain below:

1) In first a primary random population of N individuals is generated.

2) Clustering process is applied over the primary population and individuals are grouped in cluster C.In first a primary random population of N individuals is generated.

3) The representative elements of each cluster are shown to the DM.

4) If DM is satisfied with the algorithm result, the process ends. Otherwise, the system takes subjective evaluation of DM.

5) If one or more solution be a good solution for DM, choose them to store in memory to recover them for further analysis. These solutions, called Favorites that in whole process of the DM will be visible. It allows to DM to compare each set of new solutions for best achievement and have improvement.

6) According to marks given by the DM to the representative element of the clusters and the degree of membership in each cluster, the subjective fitness evaluation for each individual is computed.

7) Chosen method for selecting individuals who are involved in the evolutionary operation is applied. In addition, elitism stores a copy of the best.

8) Crossover and mutation Operators applies with the probability is given by the DM for individuals.

9) The new population is generated and goes to step 2. In fact, at the end of the algorithm, the born chromosome counts as the individual of new generations and are added to the primary population. The answer with low fitness is deleted and algorithm continues the work by n individual again.

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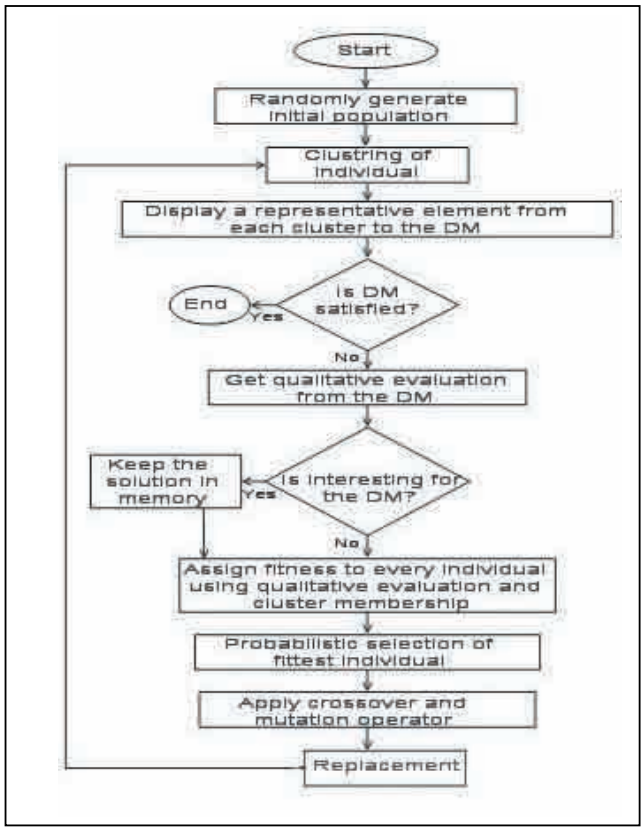


Figure 2. Proposed IGA flow diagram

Selection operator

Based on the subjective evaluations, each individual will choose to transition to the next generation.

Tournament selection is as the following:

Population is divided into several groups, and then each individual of his group was higher fitness value are transmitted to the next generation. Elitism is used to keep a number of best individuals by IGA in each generation (Mitchell, 1998). In addition, memory system that is applied for save the DM solutions is Prevents to lose them in IGA evolution. DM can see the solutions generated by the system to evaluate and the

solution is kept as a favorite, on the screen. This method cause that DM compare each new solution to get easy access and more improve.

Crossover operator

Crossover is a process which the older generation of chromosomes are combined together create a new generation of chromosomes.

Pairs were in selection part considered as a parent, in this part exchange their genes with each other to born new individuals. Crossover in genetic algorithm causes loss fragmentation or population genetic diversity because it allows good genes find each other. See "Fig. 3", on left crossover that is a one-point crossover, First random number in the range (1, Length-1) is generated. Then first part of the parent chromosome are transmitted the child chromosomes and then to complete the second part of each child's chromosomes, the other parent chromosome review from first and any number that aren't in child chromosome will transfer from parent chromosome. On right crossover that is a two-point crossover, 2 random numbers in the range (1, Length-1) is generated. Each chromosome of the two cut points are found and replaced with another.

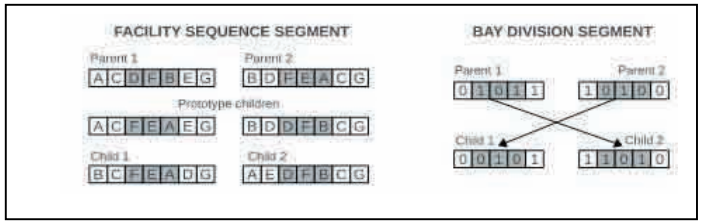


Figure 3. Crossover operator example (Garcia, 2013)

Mutation operator

In a mutation may be a Gene removed from the set of genes or gene is not present in the population until yet, be added. Mutation of a gene means that the gene mutated and used in different ways depending on the type of encryption. Mutation size should be controlled and mutation operator must get to a valid chromosome. Usually the mutation operator with P_ m probability is applied ($0.005 < P_m < 0.05$).

Example: real number code

Several genes are randomly selected and then added or less a random value from it.

(3.24 9.53 7.86 8.11 2.12)
(3.24 9.53 7.73 8.22 2.12)

Visual information

The usefulness of visualizing the information has been proposed outstanding. To display better and better information about each facility layout, DM can easily use interactive approach using a variety of graphical information, See "Fig. 4".

10) The gray lines represent the material flow between each pair of facilities. To avoid visual overloading currents are displayed with the highest value for DM. There is a parameter for this selection how many of the highest value are shown all the material flow that exist in the plant. This issue that should be enough space to carry the materials flow also has been proposed.

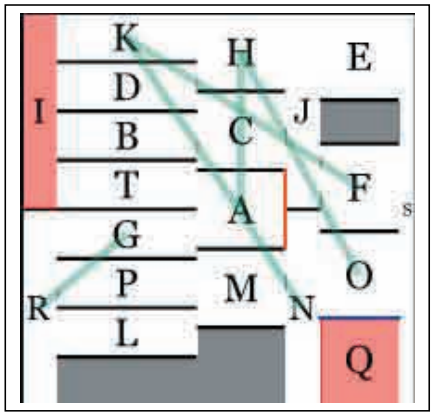
11) If the adjacency relationship between a pair of facilities of a DM be an appropriate type, is placed between the pair of blue line. Otherwise, if an adjacency relationship of facilities be in unappropriated type, the background is red.

12) A dark red line between a pair of the DM facilities show the required distance isn't Right.

13) Those facilities with a gray background show the remaining space left on plant layout.

In most cases the plant layout area is more than area required for all facilities, so that the remaining spaces appear in the UA-FLP. Some part of them can be important to design a plant layout because depending on the condition can define the specific solution that is better than the other. For example, DM can be focused on the remaining space on the part of the plant layout or can be interested in the solution which all the distributed remaining space in the plant layout is used at useful

type. DM to distribute the remaining space in the layout offers a variety of methods. The following method for allocate the probable remaining space has been proposed. At first, the average area of all facilities that make up the plant layout using the formula (2) is calculated.



$$av = \frac{\sum_i A_i}{n} \qquad (2)$$

Figure 4. A particular solution example

In This formula av is average area of the facilities that are available in the layout, Ai is the area of the facility and n is the number of facilities in the layout. Then the remaining space is divided into portion of the size of the average area and a portion with the rest. In this method, all the remaining space is allocated into blocks whose area is not larger than the average area of all the facilities that make up the plant.

4. Proposed Algorithm

In IGA algorithms how the most optimal solution is transferred to the next generation have been mentioned. In This algorithm from randomly chosen population, just each cluster representatives were introduced to the DM And if the DM was satisfied from the algorithm result then the work would end, Otherwise in the quality evaluation of the DM, the bests were selected among the representatives and the DM can save

them in its memory to have best results in every generation in its memory, and are detailed evaluation in the next steps and the crossover and mutation operators applied on them. Also at the end, each new generation's population is replaced with last population. The interactive genetic algorithm stops when it reaches a good solution. The number of generations measures the cost of DM's fatigue.

Now our offer for this algorithm is as below:

At first a random population of n persons is selected, in the next step an inherited evaluation applied on elements of populations and an average of the evaluation result is calculated. In The next step only the elements passed to next clustering level that result of their evaluation is equal to or greater than the average of the evaluation's result. This method causes that from primary population, only some part that earned a high and good evaluation, get clustered. Thus, in smaller number of generations, the best of population transferred and thus reduced fatigue costs of DM. Our proposed algorithm is as follows:

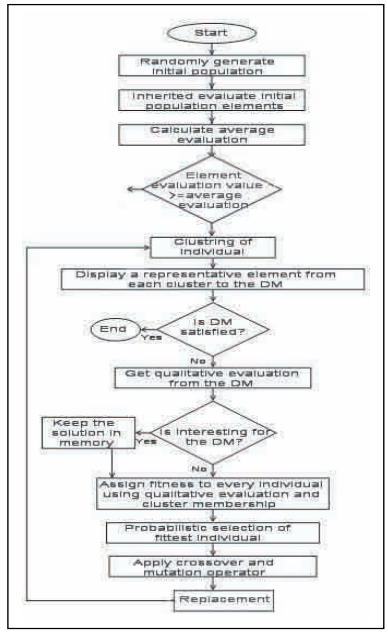


Figure 5. Proposed Algorithm

5. Conclusion

Interactive Genetic Algorithm is able to use the DM's expert knowledge to making UA-FLP plant. This approach, allows the DM to interact with the algorithm to lead the search process. In the proposed method the DM is widely evaluated and in each evaluation a subset of best solutions from total population in each generation of interactive genetic algorithm is presented. The final solution is approved by the DM. This solution is achieved by get a number of appropriate generations that the number of generations is depended on primary populations which randomly selected and since in the proposed algorithm, at first the random population was evaluated, number of generations will be less than the previous method. In the end, the DM has the ability to store the optimal solutions in its memory and storing these solutions is so important and affective for next generations.

Number of essential generations to reach a satisfactory solution is different for DM that it's because of the random nature of the genetic algorithm among the frequencies.

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