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Population Resizing on Fitness Improvement Genetic Algorithm to Optimize Promotion Visit Route Based on Android and Google Maps API

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Abstract. The promotion team of Muria Kudus University (UMK) has done annual promotion visit to several senior high schools in Indonesia. The visits were done to numbers of schools in Kudus, Jepara, Demak, Rembang and Purwodadi. To simplify the visit, each visit round is limited to 15 (fifteen) schools. However, the team frequently faces some obstacles during the visit, particularly in determining the route that they should take toward the targeted school. It is due to the long distance or the difficult route to reach the targeted school that leads to elongated travel duration and inefficient fuel cost. To solve these problems, the development of a certain application using heuristic genetic algorithm method based on the dynamic of population size or *Population Resizing on Fitness Improvement Genetic Algorithm* (PRoFIGA), was done. This android-based application was developed to make the visit easier and to determine a shorter route for the team, hence, the visiting period will be effective and efficient. The result of this research was an android-based application to determine the shortest route by combining heuristic method and *Google Maps Application Programming Interface* (API) that display the route options for the team.

INTRODUCTION

Muria Kudus University (UMK) is a public university located in Northern Javanese Island (Pantura) precisely in Kudus Regency. The university functions just like another university, every new academic year UMK assigns promoting the team to promote the university related to new college student recruitment in some senior highs schools. One of the promoting activities done by promoting team was to visit schools by distributing promotion attribute such as, brochure, poster, calendar, and merchandise. However, during the execution, the team had difficulty to find a route towards the schools. This was due to the long distance or the school had difficult route caused longer time to take and inefficient fuel cost.

Genetic Algorithm is one of the heuristic method used to solve the optimization problem in the case of *Travelling Salesman Problem* (TSP). One of the developments of this genetic algorithm method is *Population Resizing on Fitness Improvement Genetic Algorithm* (PRoFIGA), a calculating model to determine population size dynamically based on best fitness score on the previous generation used to the next generation [1] (Eiben *et al*, 2004). PRoFIGA Algorithm used to avoid any early convergence during iterating progress to determine the most optimal result.

TSP is solved by the display of the shortest route on the map by using *Google Maps Application Programming Interface* (API) that can be obtained freely. Based on the problem on this study, the researchers were interested to solve it by developing an application which implies PRoFIGA algorithm to find the shortest route for the promotion team by utilizing *Google Maps Application Programming Interface* (API) on android *Smartphone* to assist the user's mobility.

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Genetic Algorithm

Soft Computing is a heuristic model to solve computing problem by adapting human logical thinking and has the capacity to think and learn any full of doubt situation (1). Some components in *Soft Computing* is evolutionary computation or genetic algorithm, fuzzy system, and probability. A genetic algorithm is one of *Soft Computing* models introduced by John Holland of Michigan University in 1975 that is used to solve the optimization problem. It consists of several stages: (1) representing chromosome, (2) initiating population, (3) calculating evaluative functions, (4) selecting process, (5) genetics operations included *crossover* and mutation, (6) determining parameters of controlling genetic algorithm, including population size, crossover probability, and mutation probability (2).

In employing PRoFIGA, the level of various individual chromosomes in the population should be maintained properly, so there is no individual homogeneity since it might probably cause an early convergence. The steps or methods used in PRoFIGA are to create an optimal solution and to prevent homogeneity of individual or chromosome in population, which is stated as follows [2]:

- If new population size increases then any new individual will be raised randomly based on chromosome type used as many as the increasing number of population.
- If new population size decreases then new population created by using these formulas:
    - 30 percent (30%) of new population taken from the previous population have the best fitness score.
    - 30 percent (30%) of new population taken from the previous population have worst fitness score.
    - Rest of them, 40 percent (40%) taken randomly from the previous population.

Literature Review

Eiben, *et al.* [1] explained the population size dynamics in a genetic algorithm to the development of best resulting speed and to avoid any homogeneity of the individual population to cause any early convergence. *Population Resizing on Fitness Improvement Genetic Algorithm* (PRoFIGA) is one of development genetic algorithm methods on population size dynamic, in which population size on the next generation may vary based on the best coefficient fitness score condition of the previous generation.

A useful application to determine the goods distribution route in Java Island has been used the genetic algorithm. This application used a genetic algorithm to solve the problems of selecting an optimal route. The weakness of this research is the static coordinate point of the goods distribution location, so it will be difficult if there is any new location added and it still uses a standard genetic algorithm (4).

Similarly, Nurzaki [2] investigated genetic algorithm to find the shortest route to handle any critical situation in Semarang City, explained that by using a genetic algorithm, the SAR team of Semarang City could select the shortest route to reach the target area. This research has weakness points, which are its limited locations because it investigated a local scale and the use of the standard genetic algorithm.

RESEARCH METHODOLOGY

In this research, the developing method used to apply PRoFIGA algorithm based on android and GPS was the *waterfall* method. *Waterfall model* is the most popular model and often assumed as a classic approach in the cycle of developing a system (8).

RESULTS AND DISCUSSION

PRoFIGA Algorithm

The steps of *Population Resizing on Fitness Improvement Genetic Algorithm* (PRoFIGA) are elaborated as follows:

1. **Initialization of population,** a stage in which population is being initialized into a simpler form to process such as in biner, integer or permutation. Subsequently, the population is determined based on the number of preferable population size.

2. **Evaluation** is to calculate step of fitness score of each individual chromosome.
3. **Selection** is a process of ordering fitness score of each individual in the preferable population and progressed to the next step, *Crossover*.
4. **Crossover** is cross-mutation in which 2 individual chromosomes will be chosen randomly and will be mutated across its genes. The selection of individual chromosome done by using determined probability score of *crossover*.
5. **Mutation** is a stage in which gen inside of the chromosome will be changed or exchanged with other genes. The gen selection which will be mutated based on the determined mutation probability.
6. **Changing Population Size** is to check process of best fitness score. This process is started on the second generation. Where the best fitness score of the first generation is compared with the fitness score of the second generation. If the fitness score of the second generation is better than the population size, the next generation will be increased based on the given formula. Meanwhile, if the fitness score of the second generation decreases, then the population score of the next generation will be reduced.
7. **Re-evaluation process to the next generation.**

Actors Analysis

The actors involved in the system are as follows:

1. The division of university visit and road show that determines the targeted senior highs school should list the schools and set the coordinates in the application.
2. The visiting team, people who visit the schools based on the list determined by the division of university visit and road show.

Business Process

The business process in the system can be seen in Table 1.

TABLE 1. Diagram of System Use Case Process

Num	Business Process	Actors	*Use Case*
1	The users add, change and delete district data	Division of visit and road show	District enlisting process
2	The users add, change and delete school data and their coordinates.	Division of visit and road show.	School enlisting
3	The users choose a preferable location to visit.	Visit team	Choosing schools.
4	The users commence finding shortest route process on the school list to visit	Visit team	Finding route.
5	The users can see the shortest route based on the finding results by the system.	Visit team	Looking the results.
6	The users see the resulted route on GPS map	Visit team	Looking the route map.

Use Case Diagram

Based on the business processes above, it can be determined that there were 6 use cases and 2 actors.

Class Diagram

Based on the *use case*, *diagram class* was developed by creating objects (class) that would be used in the system.

Discussion

a. Face to face system

Face to face system in determining the shortest route for the visiting team to reach the targeted schools is presented in Fig. 1 and 2. Fig. 1 is face to face used to add new school data. Meanwhile, Fig. 2 is face to face to locate school based on the *Google Maps*.

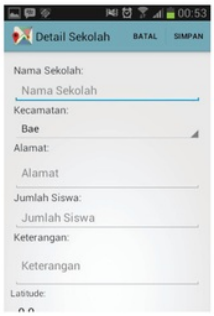

Figure 1. Adding school data

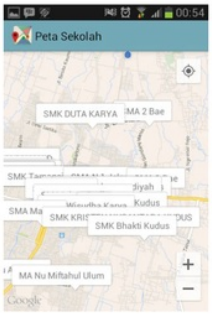

Figure 2. School location based on Google Maps

While doing promoting visit, the team must previously select the school list to visit and then search the shortest route by clicking *Generating Route* button just like in Fig. 3. After doing the iteration process to find the shortest route, searching results for the shortest or closest route and the school lists to visit will appear. It can be seen in Fig. 4.

Figure 3. Iteration process

Figure 4. List of school to visit

b. System Testing

In PRoFIGA algorithm, the best searching solution is done randomly inside of some generation to find the best solution. In the testing, the routes of several schools were examined. Subsequently, it was processed in PRoFIGA algorithm based on several parameters as follows:

1. Population Initialization

To simplify the calculation process, the schools were coded into several forms, for instance: A for MA Banat NU Kudus, B for MA Ma'ahid and so on. This initialization was used to raise population based on the determined size, which was 50. Initialization type was permutation type as shown by the following example:

Chromosome (1) = (E A B D C)

2. Population Evaluation

After the former population was formed, the fitness score of individual fitness was calculated, in this case was the shortest distance from school list order to visit. Example Fitness (1) = EA + AB +BD +DC = 2.2 + 2.0 + 4.7 + 6.9 = 23.9

3. Selection

The next step was to select the shortest route, then chromosome with the lowest fitness score was probably included in the next generation. In this research, the selection method was the roulette wheel.

4. *Crossover*

The process was to choose several individuals that will experience *crossover*. To determine these individual(s) who will be *crossover*, then probability score of its *crossover* must be determined by using *Ordered Crossover*.

5. Mutation

Mutation method used in this testing was *Swap Mutation*. The process is by selecting gen position randomly, and exchanging them with the next genes. The chosen genes based on the determined mutation probability score (pm0. The used pm score was 0.01.

6. The Changing of Population Size

In this research, the changing of population size will be started on the third generation by using several rules as follow:

- The increasing population size, if fitness score of the current generation better than the previous one, the increase of the population used this formula:

$$X = increaseFactor \times (maxEvalNum - currEvalNum) \times \frac{maxFitness_{new} - maxFitness_{old}}{iniMaxFitness}$$

- The decreasing population size, if the fitness score of the current generation lower than the previous one. The decreasing of percentage score is a low percentage between 1 until 5 percent (1-5%) [1]. The same condition also is performed if the fitness score is maximum based on the previous generation and the current one is equal then the population size decreases by decreasing percentage score defined by the users. In this research, the decreasing percentage score used is 5%

7. Stop Condition

In this research, this iterating process stops if it achieves the determined generation or the best fitness score of the 3 (three) latest generations are same.

In this test of school list above used PRoFIGA algorithm, it can be determined that the shortest route or the closest one was 56.0827 Km.

CONCLUSIONS AND SUGGESTIONS

a. Conclusion

Based on the research, some conclusions can be formulated as follows:

1 The implementation of PRoFIGA algorithm could accelerate the finding process for the shortest route that can be used by the promotion team of UMK to visit senior high schools effectively and efficiently.

3. The implementation of PRoFIGA algorithm in the form of android-based application and *Google Map Service* can be very useful for the users to utilize application due to its easy mobility and accurate appearance of route on the map.

b. Suggestions

The research has some weakness points, therefore further research is required. Some suggestions were formulated as follows:

1 Further research is required related to the increased determination or decreased population based on the best fitness school on the previous generation due to the increasing or decreasing rule in population size is still controlled manually.

4. It is expected that there will be a comparative study to investigate some genetic algorithm types to find the optimal algorithm to create solution.
5. It is expected that the application will be developed by improving the application performance in order to be quicker and lighter and also can be used on any iOS operating system-based devices.

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