2022 IEEE World AI IoT Congress (AIIoT 2022)

Seattle, Washington, USA
6 – 9 June 2022

IEEE Catalog Number: CFP22AJ4-POD
ISBN: 978-1-6654-8454-1

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ISBN (Print-On-Demand): 978-1-6654-8454-1
ISBN (Online): 978-1-6654-8453-4

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Published in: 2022 IEEE World AI IoT Congress (AIIoT)

Date of Conference: 06-09 June 2022

Date Added to IEEE *Xplore*: 13 July 2022

▸ **ISBN Information:**

INSPEC Accession Number: 21864648

DOI: 10.1109/AIIoT54504.2022.9817173

Publisher: IEEE

Conference Location: Seattle, WA, USA

I. Introduction

Logistics is one of the most important activities in human life as a personal or organizational need. It refers to any activities related to the movement of goods [1]. The goods can be raw material, semi-finished, or finished products. The movement can be from one business to another in the same sector or different sectors. It can also be from manufacturers to end customers directly or through distributor or retailers. Another definitio[...]ed by the American Council of logistics Management [2]. The logis-tics is defined as a pr[...]d controlling flow and storage product to meet the customers requirements. The logistics may involve different types of activities such as transportation, inventory maintenance, order processing, acquisition, protective packaging, warehousing, materials handling, and information maintenance

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Genetic Algorithm for Logistics-Route Optimization in Urban Area

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***Abstract*—This paper presents an optimal solution of logistics-route planning especially in urban areas. This study is motivated by a significant increment of parcel deliveries due to the fast growing e-commerce sector. The parcel deliveries are a logistics activity, where transportation is one of the main concerns. The transportation gives a significant contribution to the logistics cost such that minimising it is desired. The transportation cost can be reduced through several methods and one of them is minimizing the travel distance. There are many route options for delivering the parcels but not all of them are the minimum-distance route. Finding the minimum-distance route is an optimization problem which is not an easy problem. In this study, the genetic algorithm (GA) is applied to obtain the optimal route which is the shortest distance route. A case study of planning a route for delivering 20 parcels in Tangerang Selatan City is presented. The route planning and GA are implemented in a computer program written in Python. Executing the program resulted in an optimal route represented in a map visualization and the total distance. The optimal route was obtained through 800 iterations which were completed in less than one minute of computation.**

***Index Terms*—Genetic algorithm, Route optimization, City logistics, Transportation,**

I. Introduction

Logistics is one of the most important activities in human life as a personal or organizational need. It refers to any activities related to the movement of goods [1]. The goods can be raw material, semi-finished, or finished products. The movement can be from one business to another in the same sector or different sectors. It can also be from manufacturers to end customers directly or through distributor or retailers. Another definition about logistics was also introduced by the American Council of logistics Management [2]. The logistics is defined as a process of planning, implementing, and controlling flow and storage product to meet the customers requirements. The logistics may involve different types of activities such as transportation, inventory maintenance, order processing, acquisition, protective packaging, warehousing, materials handling, and information maintenance [3].

The logistics has a purpose to creates a value of product to the customers, suppliers, retailers, and stakeholders. The value is represented by two variables, time and location. A product may have less value or no value at all unless it is at the right location and time according to customer needs. Logistics is a major concern in many companies to increase the product value. Unfortunately, the logistics is not free. The logistics is demanding cost that gives a significant contribution to the overall cost structure of the company.

Logistics costs may vary from company to company. The costs are influenced by several factors, such as the industry type, location of the company, location of the main market, and transportation infrastructure. A study shows that at least 6% of a company's sales revenue were spent in the logistics costs [4]. Another study reported that the logistics costs of pharmaceuticals product was 4% of sales revenue, while the logistics cost of the food product was more than 30% of the sales revenue [3]. In many companies, the logistics cost is being the second highest cost of running a business after cost of goods.

The logistics costs can be broken down into several cost components. Six cost components of the logistics were defined in [5]. Those are transportation, warehousing, stock management, administration, packaging, and indirect logistics costs. A calculation of the cost components with respect to the sales revenue was done and presented in [6]. The result showed that the transportation cost was the largest cost by spending 4.08% to 5.3% of the sales revenue. Meanwhile, the stock management cost was 1.79% to 5.7%, the warehousing was 1.75% to 3%, the administration was 0.23% to 1.5%, and other cost were 0.33% to 1.1% of the sales revenue.

Minimizing the overall costs is desired by every companies to increase the profits. It is done through minimizing the costs in any activities that may include the logistics. Since the transportation gives the biggest contribution to the logistics cost, minimizing the transportation cost will significantly reduce the logistics cost. The transportation took up one third of the logistics costs [7] and moreover, performance of the logistics is significantly affected by the transportation. There are several ways to reduce the transportation costs while maintain the logistics performance, such as fleet optimization [8]–[10] and route optimization [11]–[13]. The fleet optimization can be done through several methods, such as maximizing the fleet utilization [14], selecting the lowest fuel-consumption vehicles

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[15], and minimizing the fleet downtime [16]. Meanwhile route optimization is done by traveling on a route that re a minimum distance and travel time.

Route optimization has been an interesting research t since decades. The route optimization, also known as vel routing problems, is to optimize an itinerary of fleet takes a round trip with multiple stops [17]. The trip represent a flow of goods distribution in a city. The prev study shows that the route optimization was able to re the transportation cost significantly. A route optimization save the transportation cost about 5-30% [18]. The fast g ing e-commerce have shifted consumer behavior espec in big cities. The consumer prefers to buy good thr online market that gives more challenge to the logistics including the route optimization. This prompts to a new m development of logistics system in the cities. The scie community introduced two main concepts, known as the logistics and the urban logistics [17]. The city logisti defined as a process for totally optimizing the logistics transport activities by private companies in urban areas v considering the traffic environment, the traffic conge and energy consumption within the framework of a m economy [19]. The urban logistics is a much larger con than the city logistics. The urban logistics includes all organizational, behavioral, regulation and financing elem as well as collaborative approaches, to study the logi processes and the movements of goods and service flow urban areas [20].

Route optimization of city logistics is the concern of study. Genetic algorithm is applied to obtain the optimal r that minimizes the travel distance. A study case prese route planning in delivering packages to twenty loca in Tangerang Selatan city. Presentation of this paper is organized as follows. Section I presents an introdu that includes background, motivation, and the purpose o study. Section II presents the applied method. It is desc the theory and implementation of the genetic algorith solving the route optimization problem. The genetic algo is implemented in a computer program written in Python. route optimization is demonstrated in computer simulation the results are presented and discussed in Section III. Fin conclusion of this study is presented in Section IV.

II. Methods

This section consists of three parts: problem formulati the route optimization, genetic algorithm, and route optin tion using genetic algorithm. Each parts are described i following subsections.

A. Genetic Algorithm

Genetic algorithm (GA) is an optimization method ins by the Charles Darwin's theory of natural evolution. A na evolution usually begins with a population undergoing na selection, where only the fittest individuals are to sur Reproduction is a natural process to produce offspring that occurs in every creature, including survived individuals in the natural selection. Matting among the survived individuals will results in offspring of new generation that are fitter than their parents. This new generation will undergo natural selection and remain only the fittest individuals as the survivors. Matting among the survivors will result in newer generation which are fitter than previous generation. The processes of selection and reproduction are repeated until producing a generation where the population passes the selection process. Figure 1 illustrates the natural evolution process into a flowchart.

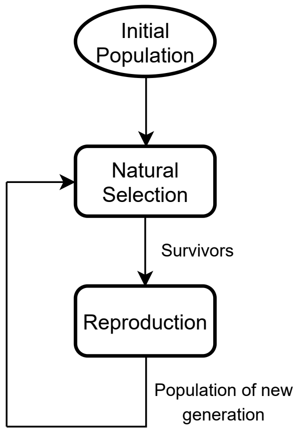


Fig. 1: Flow chart of natural evolution.

The GA was introduced by John Holland in 1970s [21]. It was developed by imitating the process of natural evolution. The GA includes several steps as shown by a flowchart in Figure 2. Those steps are basically representing the two processes of natural evolution, the natural selection and the reproduction. Each steps of the GA is explained as follows:

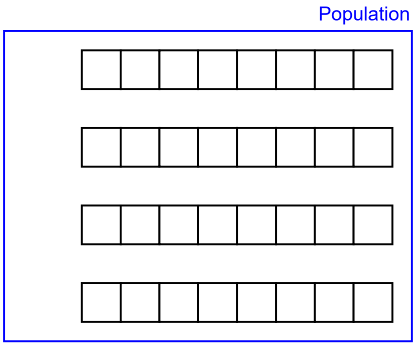
1) The GA begins by generating an initial population. The population is a set of individuals which are the solution candidates of a given problem. Each individual is represented by a chromosome which is a set of sequential parameters known as genes. This population can be mathematically expressed by the following equation:

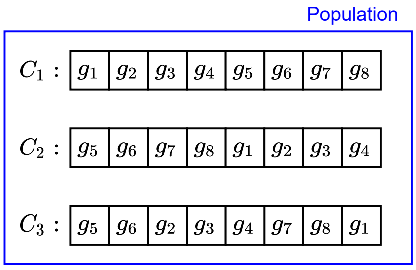
$$P = \{C_i | i = 1, 2, ..., n\} \tag{1}$$

where P is the population, C_i is the chromosome of the i^{th} individual, i is the individual number in the population, and n is the total number of individuals in the population. The chromosome C_i is a set of genes and can be mathematically expressed as follows:

$$C_i = \{g_{i_j} | j = 1, 2, ..., m\} \tag{2}$$

where g_{i_j} is the j^{th} gene of the chromosome C_i. Figure 3 shows an example of population that consists of three individuals that are represented by the chromosomes C_1, C_2, and C_3. Each chromosome consists of eight genes that are denoted by g_{i_j} as the j^{th} gene of the chromosome C_i. For an examples, the gene g_{2_3} is represent the gene number 3 of chromosome number 2.





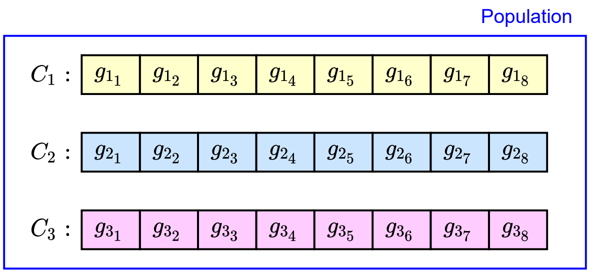
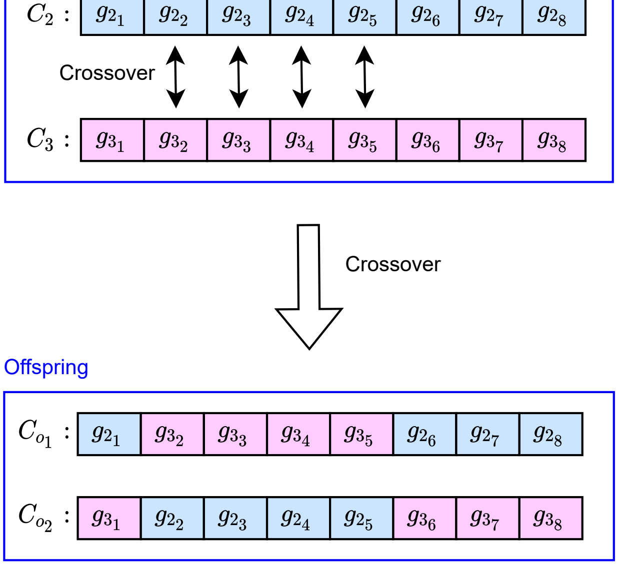


Fig. 3: Example of a population of three individuals with eight genes on their chromosomes.

2) The next step is to evaluate the fitness of each individuals in the population. The fitness evaluation is done using a fitness function that calculates a fitness score. The fitness score indicates how close the individuals to be the optimal solution of the given problem. There are several types of the fitness function that can be applied [22]. Based on the fitness score, all individuals are evaluated whether satisfying a criterion of the desired solution or not. If any individuals satisfies the criterion then the solution of given problem is obtained and the process of the GA is completed. However, if no one meets the criteria, then the GA process is continued by applying the GA operator.
3) In case, no individuals in the current population meets the solution criteria, GA operator is applied to produce a new generation that is fitter than the current generation. The GA operator imitates the selection and reproduction in natural evolution. The GA operator includes three operations: selection, crossover, and mutation. Those operations are explained as follows:
   a) The selection is to choose the fittest individuals only. This selection is done based on the fitness score, where the individuals with the highest fitness scores are selected, while the others are dismissed. These selected individuals are known as the fittest individuals or the survivors. Assuming that from the initial population, no individuals satisfies the criterion such that the GA operator is applied and only the individuals C_2 and C_3 passed the selection. Both C_2 and C_3 are being the parents to produce offspring for the next generation.
   b) The crossover is an imitation of reproduction process to result in offspring. The crossover is done by exchanging genes of parents chromosomes to produce new chromosomes as the offspring. The exchange can be done on one or more genes. Figures 4 shows an example of crossover by exchanging four genes which are the genes number 2 to 5 of the parents chromosomes, C_2 and C_3. This crossover results in new individuals named the C_{o_1} and C_{o_2}, where their chromosomes are composed by a combination of the parent chromosomes. The crossover can be done by different combination and the exchanged genes numbers, and will result in many new individuals as the offspring. These new individuals build a new population.
   c) The mutation is a change in the genes sequence of a chromosome. It is purposed to maintain genetic diversity in the population. The mutation can help to overcome local minimal in finding the global optima. There are several methods of mutation [23], such as twors mutation, center inverse mutation, reverse sequence mutation, throas mutation, thrors mutation, and partial shuffle mutation (PSM). Each mutation type may result in GA with different performance [24]. Figure 5 shows an example of mutation based on the twors mutation method. The twors mutation is the simplest mutation which is done by randomly swapping two genes in a chromosome. The mutation was happen on the new individual C_{o_1} where the genes number 3 and 7 are swapped. The mutation results in a new individual denoted by $C_{o_1}m_1$
4) The GA operator results in a new population as the new generation. In order to obtain a solution that matches



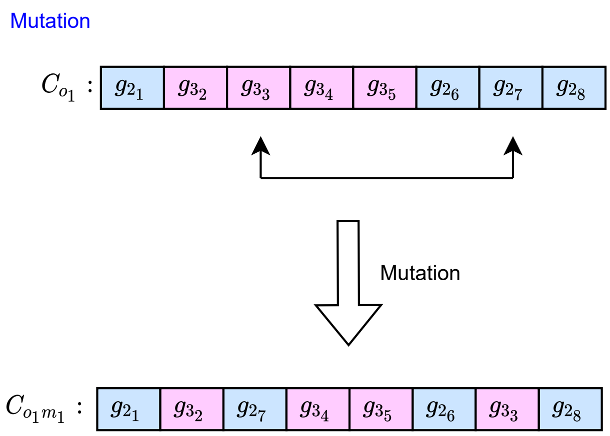


Fig. 5: Example of a mutation by randomly swapping two genes on a chromosome.

to the criterion, the new population comes to the the fitness evaluation as the process backs to the step 2. These processes are repeated until the criterion is satisfied.

B. Route optimization problem

Route optimization in transporting logistics is one of the most common problems in city logistics. The rapidly growing online market has resulted in a significant increase in the volume and frequency of parcel deliveries in major cities around the world and including Indonesia. The route optimization is to obtain a route for traveling from a departure point to all destination points with the best effort. The best effort can be described by different parameters depend on the objective, such as minimum travelling distance, minimum

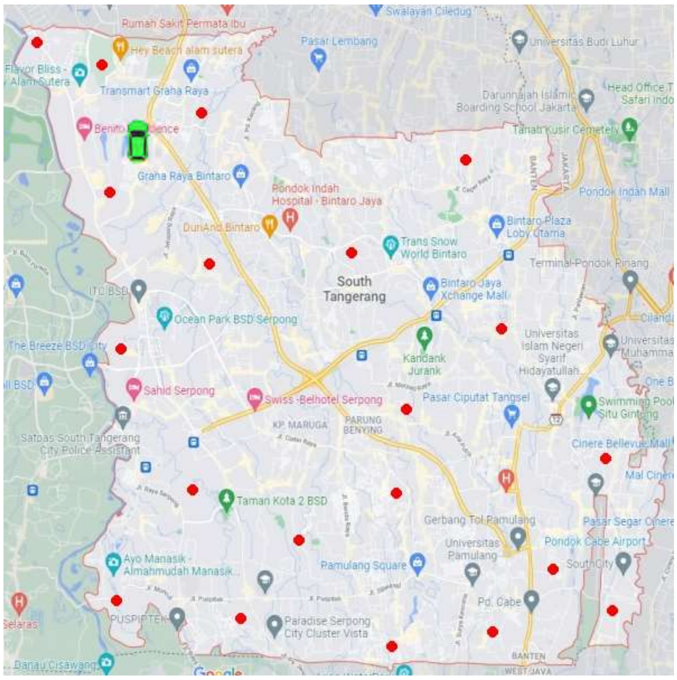


Fig. 6: Map of the logistics office locations (car) and the locations of package destination (red dots).

traveling time, or minimum fuel consumption. Assuming that the three parameters are proportional to each others, where the minimum distance results in the minimum time and minimum fuel consumption, and vice versa. Therefore, the objective of route optimization is to minimized the travelling distance.

This study presents a case of routing problem in logistics company to deliver packages in Tangerang Selatan. The objective is to obtain a route that results in minimum travelling distance in delivering the packages. Tangerang Selatan is one of the big cities in suburban Jakarta. It was populated by 1.8 million people in 2020 with the area of 147.2 km^2. Figure 6 shows a map of the logistics office indicated by the green car and the packages destination as indicated by the red dots. There are many red dots in the map and the k^{th} red dot is called the p_k. It is defined that the p_0 is the location of the logistics office. Location of the p_k is expressed by coordinate (x_k, y_k). Route in delivering the packages is a round-trip route where the starting and finishing points are located at the same point which is the logistics office. Moreover, the route is only visiting a destination one time. The total travel distance is defined as an accumulated distance between the destinations in the route.

Distance between two destinations p_k and p_{k-1} is calculated based on the Euclidean distance as follows:

$$d_k = \sqrt{(x_k - x_{k-1})^2 + (y_k - y_{k-1})^2}, \qquad (3)$$

where d_k is the distance between p_k and p_{k-1}, x_k and y_k are the coordinate of p_k, and x_{k-1} and y_{k-1} are the coordinate of p_{k-1}. Meanwhile, the total travel distance is an accumulated distance and defined as follows:

$$D = \sum_{k=1}^{m+1} d_k = \sum_{k=1}^{m+1} \sqrt{(x_k - x_{k-1})^2 + (y_k - y_{k-1})^2} \quad (4)$$

where m is the number of destinations. The coordinates (x_0, y_0) is the departure point and (x_{m+1}, y_{m+1}) is the last destination. Both (x_0, y_0) and (x_{m+1}, y_{m+1}) are the same place.

III. Results

The GA algorithm is applied to optimize route in delivering packages by resulting in minimum travel distance. The pack-

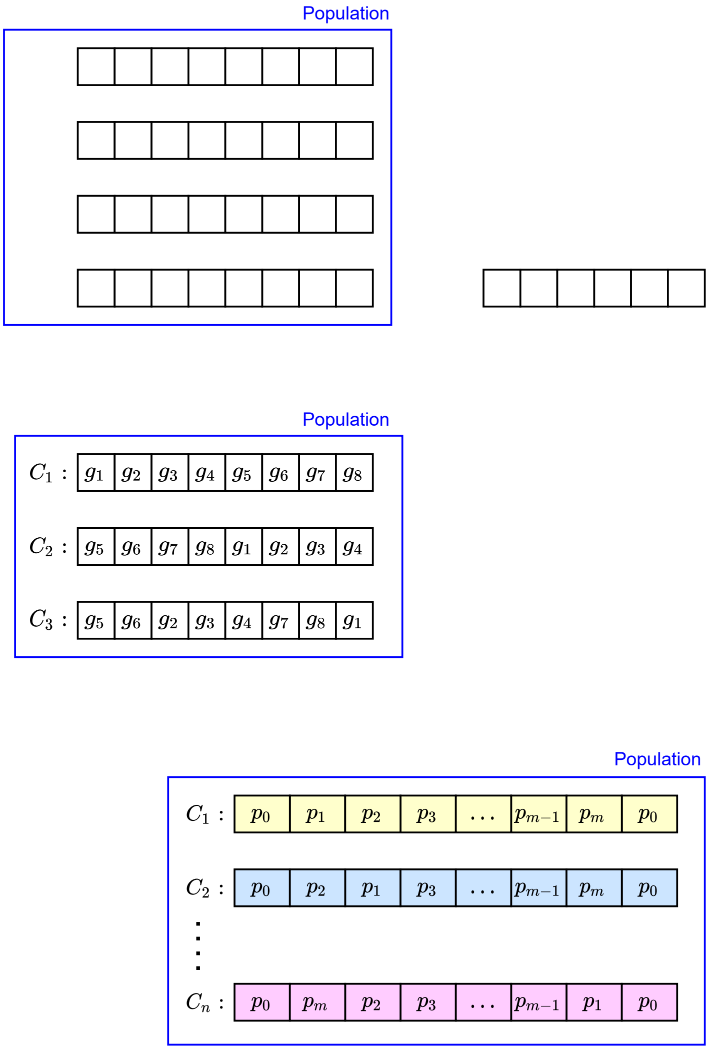
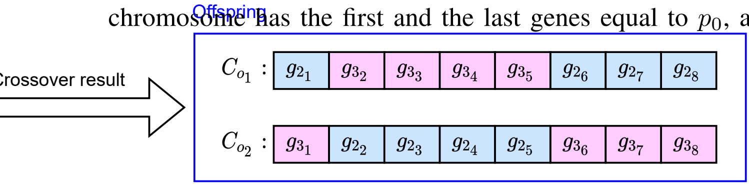
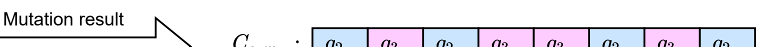


Fig. 7: Population of the routing problem.

The fitness evaluation is done by evaluating that each chromosome has the first and the last genes equal to p_0, and





the other genes represent all destinations. Since the minimum travel distance is actually unknown, the solution criterion is satisfied by the iteration number. In this case, the iteration number should be selected as a big enough such that the travel distance does not change for a long iteration.

Algorithm 1: Classical genetic algorithm

Input :
Population size, n
Maximum number of iteration, MAX
Output:
Global best solution, Y_{bs}
begin
Generate initial population of n chromosomes, Y_i
Set iteration counter $t = 0$
Compute the fitness value of each chromosomes
while $t < MAX$ **do**
Select a pair of chromosomes from initial population based on fitness
Apply crossover operation on selected pair with crossover probability
Replace old population with newly generated population
Increment the current iteration t by 1
end
Return the best solution, Y_{bs}
end

A computer program is developed in Python to implement the GA in solving the routing problem. Algorithm of the program is shown in Algorithm 1. There are 20 destinations in delivering the package. The program creates 50 individual of population in each generation. Iteration of the program is limited up to 5000 such that the program simulates up to the 5000^{th} generation. Running the program resulted in the total travel distance shown in Figure 8. The figure shows that the best individuals in the first generation resulted in a total distance of 58 km. The total distance decreases significantly from the generation 1 to the generation 800 and resulted in the total travel distance of 31.46 km. There is no change in total distance from generation 800 to generation 5000. Therefore, the optimal route in delivering the package resulted in total distance of 31.46 km. Visualization of the optimal route is shown in Figure 9.

IV. Conclusion

A study of finding optimal route as solution in city logistics has been presented by applying the GA algorithm. A study case presented a routing problem to deliver packages to 20 different destinations. The GA algorithm was implemented and simulated in a Python program. The simulation results shown that the GA was able to solve the routing problem. The optimal solution was obtained within 800 iterations which required computing time less than a minute. The optimal route resulted in a total travel distance of 31.26 km for delivering packages to the 20 destinations. This results show that the GA is very

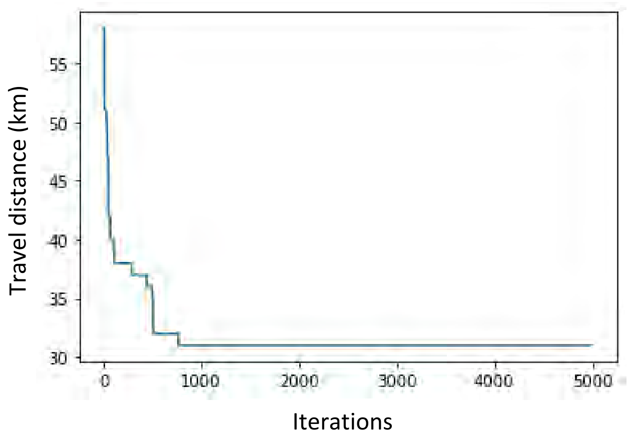


Fig. 8: The total travel distance at each generation.

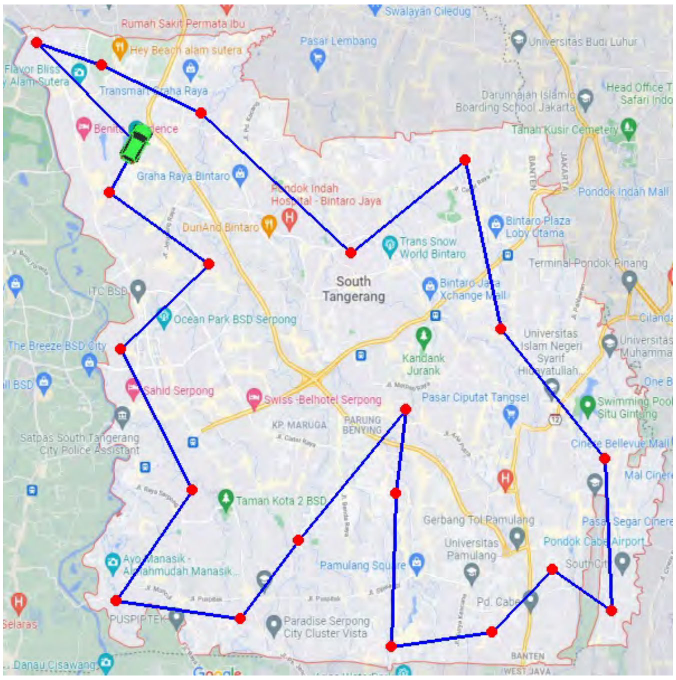


Fig. 9: Optimal route for delivering the packages.

effective in solving the routing problem. Applying the GA in more complex routing problem and considering actual road traffic condition is considering as a further study.

Acknowledgement

The authors acknowledge a financial support from Universitas Pembangunan Jaya through Internal Grant No. 002/PER-P2M/UPJ/11.21.

References

[1] N. Viswanadham and R. Gaonkar, "E-logistics: trends and opportunities," *E-Logistics Research WP: TLI-AP/01/01, January, The Logistics Institute Asia-Pacific*, 2001.

[2] A. Kumar, "Green logistics for sustainable development: an analytical review," *IOSRD International Journal of Business*, vol. 1, no. 1, pp. 7–13, 2015.

[3] R. H. Ballou, "Business logistics: importance and some research opportunities," *Gestão & Produção*, vol. 4, pp. 117–129, 1997.

[4] R. Muha, "An overview of the problematic issues in logistics cost management," *Pomorstvo*, vol. 33, no. 1, pp. 102–109, 2019.

[5] A. Z. Zeng and C. Rossetti, "Developing a framework for evaluating the logistics costs in global sourcing processes: An implementation and insights," *International Journal of Physical Distribution & Logistics Management*, 2003.

[6] J. Engblom, T. Solakivi, J. Töyli, and L. Ojala, "Multiple-method analysis of logistics costs," *International Journal of Production Economics*, vol. 137, no. 1, pp. 29–35, 2012.

[7] Y.-y. Tseng, W. L. Yue, M. A. Taylor *et al.*, "The role of transportation in logistics chain." Eastern Asia Society for Transportation Studies, 2005.

[8] Y. Yang, Z. Yuan, X. Fu, Y. Wang, and D. Sun, "Optimization model of taxi fleet size based on gps tracking data," *Sustainability*, vol. 11, no. 3, p. 731, 2019.

[9] B. Wang, S. A. O. Medina, and P. Fourie, "Simulation of autonomous transit on demand for fleet size and deployment strategy optimization," *Procedia computer science*, vol. 130, pp. 797–802, 2018.

[10] C. Both and R. Dimitrakopoulos, "Joint stochastic short-term production scheduling and fleet management optimization for mining complexes," *Optimization and Engineering*, vol. 21, no. 4, pp. 1717–1743, 2020.

[11] W. Liu, "Route optimization for last-mile distribution of rural e-commerce logistics based on ant colony optimization," *IEEE Access*, vol. 8, pp. 12 179–12 187, 2020.

[12] D. Li, Q. Cao, M. Zuo, and F. Xu, "Optimization of green fresh food logistics with heterogeneous fleet vehicle route problem by improved genetic algorithm," *Sustainability*, vol. 12, no. 5, p. 1946, 2020.

[13] W.-C. Hu, H.-T. Wu, H.-H. Cho, and F.-H. Tseng, "Optimal route planning system for logistics vehicles based on artificial intelligence," *Journal of Internet Technology*, vol. 21, no. 3, pp. 757–764, 2020.

[14] A. Galkin, M. Olkhova, S. Iwan, K. Kijewska, S. Ostashevskyi, and O. Lobashov, "Planning the rational freight vehicle fleet utilization considering the season temperature factor," *Sustainability*, vol. 13, no. 7, p. 3782, 2021.

[15] Y. Huang, N. C. Surawski, B. Organ, J. L. Zhou, O. H. Tang, and E. F. Chan, "Fuel consumption and emissions performance under real driving: Comparison between hybrid and conventional vehicles," *Science of the Total Environment*, vol. 659, pp. 275–282, 2019.

[16] A. Puzyrevskaya, N. Pogotovkina, Y. N. Gorchakov, and V. Ovsyannikov, "Shortening unscheduled downtime for more efficient use of haul trucks," in *IOP Conference Series: Earth and Environmental Science*, vol. 988, no. 4. IOP Publishing, 2022, p. 042036.

[17] D. Cattaruzza, N. Absi, D. Feillet, and J. González-Feliu, "Vehicle routing problems for city logistics," *EURO Journal on Transportation and Logistics*, vol. 6, no. 1, pp. 51–79, 2017.

[18] G. Hasle, K.-A. Lie, and E. Quak, *Geometric modelling, numerical simulation, and optimization*. Springer, 2007.

[19] E. Taniguchi, R. G. Thompson, T. Yamada, and R. van Duin, "Modelling city logistics," in *City logistics*. Emerald Group Publishing Limited, 2001.

[20] S. Anderson, J. Allen, and M. Browne, "Urban logistics—-how can it meet policy makers' sustainability objectives?" *Journal of transport geography*, vol. 13, no. 1, pp. 71–81, 2005.

[21] J. H. Holland, *Adaptation in natural and artificial systems: an introductory analysis with applications to biology, control, and artificial intelligence*. MIT press, 1992.

[22] A. L. Nelson, G. J. Barlow, and L. Doitsidis, "Fitness functions in evolutionary robotics: A survey and analysis," *Robotics and Autonomous Systems*, vol. 57, no. 4, pp. 345–370, 2009.

[23] O. Abdoun, J. Abouchabaka, and C. Tajani, "Analyzing the performance of mutation operators to solve the travelling salesman problem," *arXiv preprint arXiv:1203.3099*, 2012.

[24] R. T. Bye, M. Gribbestad, R. Chandra, and O. L. Osen, "A comparison of ga crossover and mutation methods for the traveling salesman problem," in *Innovations in Computational Intelligence and Computer Vision*. Springer, 2021, pp. 529–542.

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GENETICS ALGORITHM FOR LOGISTIC-ROUTE OPTIMIZATION IN URBAN AREA

IN THE SESSION

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING (SESSION 3)

AT IEEE AIIoT 2022
ON 6TH - 9TH JUNE 2022

SON VUONG
General co-chair, AIIoT 2022

SATYAJIT CHAKRABARTI
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