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Crossover Methods Comparison in Flood Evacuation Route Optimization

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***Abstract*— This study aims to implement the genetic algorithm by testing the appropriate crossover methods in order to obtain optimal disaster evacuation routes based three main indicators, namely travel time, possible transportation mode, and affected road conditions. The research phase begins with establishing a flood-affected area scenario consisting of the victim's initial location, evacuation location, routing areas, affected road conditions, distance, as well as travel time. The genetic algorithm is applied by representing the genes and chromosomes based on the available data, generating the initial population and calculating the fitness value. At the stage of determining the parent in forming a new individual, roulette wheel selection is used. For the crossover method to produce new individuals, there are 3 methods tested namely single-point, two-point and uniform crossover. The new formed individuals are then mutated with a probability level of 0.1. The last stage is to form a new population by sorting individuals with the highest fitness value. These processes took place with an iteration limit of 1000. Based on the results of the implementation and tests conducted, the uniform crossover method has the most optimal results with accuracy 90% and highest fitness value of 0.896. Meanwhile, the two others methods two-point and single-point have extremely lower accuracy which are 70% and 60% respectively. This result confirmed the statement of previous research which convinced that the *uniform crossover* is the most effective crossover method.**

Keywords—optimization, evacuation route, flood, Makassar, genetic algorithm

I. INTRODUCTION

Natural disasters in Indonesia have a fairly high frequency. Based on data from the National Disaster Management Agency (BNPB), from January to October 2022 there were 3,038 incidents of which floods were the highest with 1,246 incidents [1]. Erratic weather changes, high rainfall, land conversion, as well as poor drainage are the main causes of floods [2][3]. Current effort conducted by the authorized institution to reduce the number of affected victims is by managing mitigation procedures and setting up evacuation gathering points that are close to settlements which can be easily reached by people who are around the disaster site [4]. Evacuation procedures need special attention to speed up the evacuation process, namely by determining the evacuation route to avoid vulnerable areas as well as to reduce travel time. Nowadays, navigation technology such as google maps is the most popular application to obtain information regarding distance, travel time, and road congestion. However, this application doesn't include disaster affected parameters which are important to be consider in managing disaster evacuation routes.

There are various studies related to evacuation routes approaches have been conducted, such as research by Ibnu Fadhil et.al which used distance, capacity, and road quality as indicators in determining evacuation routes with a fuzzy system [5]. In Yuliza Pratiwi et.al [6] the indicators used were distance and road quality. In this study, the authors added more specific indicators on the road conditions which are safe, vulnerable and alert roads according to the affected disaster areas, including additional indicators that are normal travel times and in traffic jams. To optimize the evacuation route to the evacuation assembly point among several possible alternative routes, an optimization method based on predetermined indicators is needed. Models commonly used in optimization problems are genetic algorithms and particle swarm optimization (PSO) [7]. A research by Delwar Tahesin Samira et.al [8] conclude that the computational results of the genetic algorithm are more effective when compared to PSO. Similar results were also obtained by Eva Hertnacahyani in her research discussing a comparative study of particle swarm optimization and genetic algorithms in foil design [9]. Those research shows that the convergence produced by PSO tends to be slower and more difficult to achieve, while the genetic algorithm has a fairly high convergence rate.

Concerning the problem has stated before as well as recommendation of the of the studies, this study is focused to apply the genetic algorithm to optimize recommendations for flood evacuation routes based on indicators of distance, affected road conditions, and travel time according to possible transportation mode. In addition, this research also tested the crossover model which includes one-point crossover, two-point crossover and uniform crossover in order to find the most effective crossover method to be used in this case.

II. RESEARCH METHOD

This research consists of several stages which includes design, implementation and testing as described in Fig. 1.

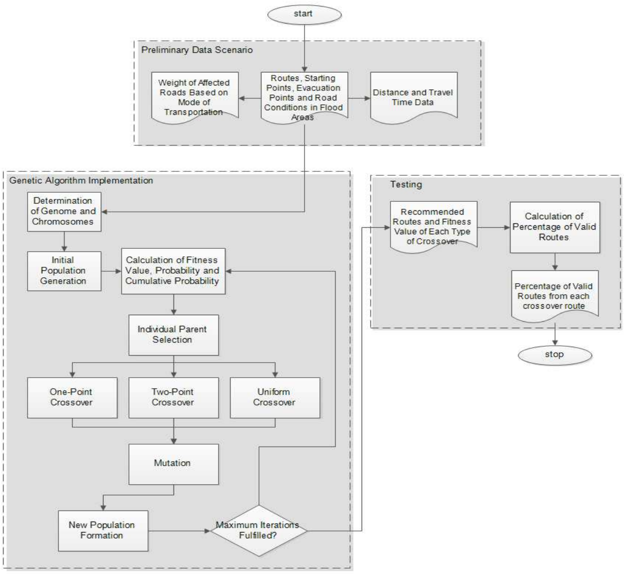

Fig 1. Research Stages

A. *Research Scenario*

In applying the genetic algorithm to optimize the evacuation route recommendations, a scenario was formed. In this scenario there are three shelters or evacuation locations around the victims affected by the flood. Routes have been grouped based on conditions and flood susceptibility around the road as presented in Fig. 2. Road sections in this scenario are symbolized by E1 to E24, while nodes or meeting points between road segments are symbolized by N1 to N16. Those route has distance, normal travel time and traffic jam time based on the transportation mode. Values of each parameter in this given scenario are presented in Table 1.

Additionally, since there are numbers of road condition affected by flood cannot be traversed by certain transportation mode, a weighting scenario were defined. The weighting score for affected road conditions were given in range of 0 to 1 as presented in Table 2. These data then are implemented in the genetic algorithm to determine the level of success in defining the evacuation route for flood disaster

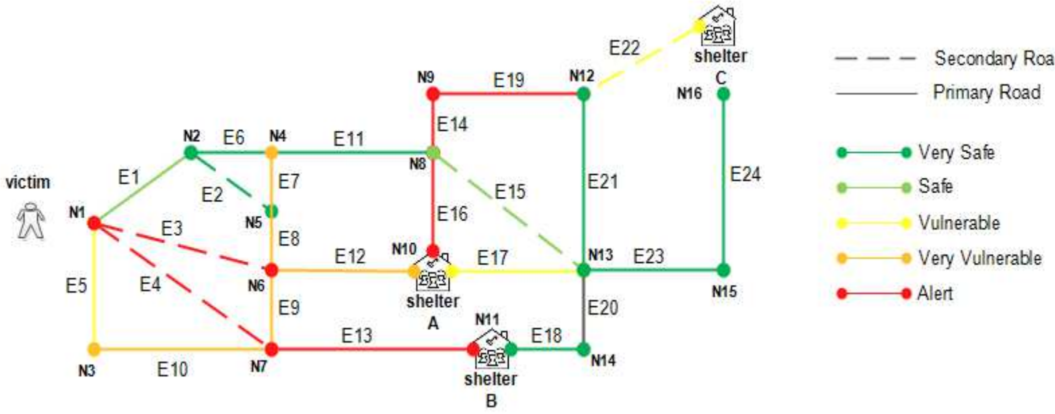

Fig 2. Flood Evacuation Route Scenario

TABLE I. PARAMETER VALUES of THE RESEARCH SCENARIO

Road Section	**Distance (m)**	**Travel Time Based on Transportation Mode & Status**									
		Car (S)		***Motorcycle (S)***		***Walking (S)***		***Cycling (S)***		***Public Transportation (S)***	
		Normal	***Traffic Jam***	***Normal***	***Traffic Jam***	***Normal***	***Traffic Jam***	***Normal***	***Traffic Jam***	***Normal***	***Traffic Jam***
E1	205	10	12	9	11	25	25	15	15	30	36
E2	180	9	13	7	11	23	23	14	14	27	32
E3	310	18	23	16	20	45	45	27	27	54	65
E4	340	20	25	17	21	50	50	30	30	60	72
E5	200	10	12	9	11	25	25	15	15	30	36
E6	100	6	8	5	7	15	15	9	9	18	22
E7	75	5	7	4	6	13	13	8	8	15	18
E8	80	5	7	4	6	13	13	8	8	15	18
E9	110	6	8	5	7	15	15	9	9	18	22
E10	300	17	19	16	18	43	43	26	26	51	61
E11	290	17	19	16	18	43	43	26	26	51	61
E12	290	17	19	16	18	43	43	26	26	51	61
E13	395	30	32	28	30	75	75	45	45	90	108
E14	100	6	8	5	7	15	15	9	9	18	22
E15	350	21	25	17	22	53	53	32	32	63	76
E16	155	8	10	6	8	20	20	12	12	24	29
E17	280	17	19	15	17	43	43	26	26	51	61
E18	100	6	8	5	8	15	15	9	9	18	22
E19	280	16	18	14	16	40	40	24	24	48	58
E20	100	6	8	5	7	15	15	9	9	18	22
E21	255	15	17	13	16	38	38	23	23	45	54
E22	220	12	17	9	13	30	30	18	18	36	43
E23	270	16	18	14	16	40	40	24	24	48	58
E24	255	15	17	12	16	38	38	23	23	45	54

TABLE II. WEIGHTING of THE TRANSPORTATION MODE

Road Conditions	Transportation Mode				
	Car	*Motorcycle*	*Walking*	*Cycling*	*Public Transp.*
Alert	0	0	0,1	0	0
V. vulnerable	0	0,2	0,5	0,3	0
Vulnerable	0,3	0,65	0,75	0,7	0,2
Safe	0,7	0,8	0,9	0,85	0,6
Very Safe	1	1	1	1	1

B. *Implementation of The Genetics Algorithm*

Implementing the genetic algorithm in this study are divided into nine stages as the following explanation.

1) *Genes and chromosomes representation*: Genes are the basic parts that make up chromosomes. A gene's values can be binary, float, integer and character. Meanwhile, chromosomes are a combination of genes that have a specific meaning, that is a solution to the problem or case investigated [10]. In this study, genes are represented as nodes or meeting points between road segments (N1 – N16) and chromosomes consist of a collection of nodes that represent routes from the starting point to the destination point. The starting node is N1 while the destination nodes are N10, N11 and N16.

2) *Initial population generation:* In this case there are 256 chromosomes generated as the initial population where each chromosome has 16 genes. Each generated chromosome must have all available genes (N1 – N16) and N1 as the first gene.

3) *Calculation of the fitness value*: Fitness or evaluation function provides an assessment for the quality of chromosomes as a reference in achieving optimal results [11,12]. This calculation begins by determining the road segment based on the sequence of the chromosome nodes. For example, from initial node N1 and destination node N2 & N4, we can define the road sections for each. Between nodes N1 and N2 there is road section E1, as well as between N2 and N4 there is road section E6. After all road sections are defined, the values of each road parameters can be obtained, namely: distance, travel time, as well as weight of the affected road by referencing data presented in Table I and Table II. The fitness value is calculated using (1).

$$f(k) = \sum_{e=1}^{n} \frac{1}{(a+h)} \tag{1}$$

Where *f(k)* is fitness value of each chromosomes, *e* is road section, a is a constant (between 0-1), h is weighting value and distance of each road section. Equation (2), (3), and (4) are used to obtain the h value.

$$h = y \,. x \tag{2}$$

$$y = \frac{1}{(n1+n2)/2} \tag{3}$$

$$n2 = (Dn - (Dt - Dn))/Dn \tag{4}$$

Where y is calculation result of the affected road weighting and travel time, x is road distance, $n1$ is weighting value of the affected road, $n2$ is travel time calculation, Dn is travel time in normal condition, and Dt is travel time in traffic jam condition.

4) *Selection methods*: The Roulette Wheel selection is used to determine which individuals are used as parents in the crossover process. This selection method is the simplest and the most commonly method used in genetic algorithms [13].

5) Crossover: Crossover is applied to maintain the diversity of chromosomes in achieving a global solution [14]. In this study, the *author* implement three types of crossover methods in determining parent, namely: *one-point crossover, two-point crossover,* and *uniform crossover*, by generating random numbers to produce new individuals with the crossover probability value 0.75.

6) Mutation: The new individual is obtained from the 2-parent crossover then mutated by generating a value to determine the position of the mutation. The mutation probability value used is 0.1

7) *Formulating new Population*: To ensure that individuals in each generation produces the best individual in the next generation, a selection is made based on the highest fitness value [15]. A new population is formed by combining previous individuals with new individuals resulting from crossover and mutation. These individuals then were filtered and taken only 256 individuals with the greatest fitness value.

8) *Max iteration*: Premature convergence interruption by applying iteration restriction is needed to prevent endless repetition of iterations [16]. In this study, the process of forming a new population was repeated with a maximum of 1000 iterations.

9) *Route Recommendation*: After the best population are obtained, the individual with the highest fitness value is taken as the most optimal route recommendation. The validity of this route is tested to determine the percentage of success.

C. *Testing*

Series of testing scenarios were conducted in order to obtain the percentage of successfulness of the genetic algorithm in this case study by testing the recommended evacuation routes. This percentage is obtained by reviewing valid routes resulted from 10 trials for each type of crossover applied. The testing results are discussed in section III.

III. RESULTS AND DISCUSSION

The implementation of 3 types of crossover in the genetic algorithm indicating different levels of success as presented ini Table III, IV and V.

A. *One-Point Crossover*

In one-point crossover, the crossover positions of the 2 parent individuals are determined randomly. Based on 10 trials conducted for the *one-point crossover* operator (in Table III), 6 trials successfully produce valid routes with the highest fitness value of 0.896.

TABLE III. TESTING RESULT for *ONE-POINT CROSSOVER*

Trials	Optimal Chromosomes	Valid Route	Validity	Fitness value
1	**n1-n3-n7-n11**-n10-n16-n15-n5-n12-n10-n14-n4-n2-n14-n8-n12	**n1-n3-n7-n11**	Yes	0,523
2	n1-n2-n4-n8-n8-n4-n5-n16-n15-n13-n14-n13-n14-n14-n13-n12	No route found	No	0,259
3	**n1-n2-n5-n6-n10**-n12-n7-n8-n12-n9-n4-n9-n11-n12-n15-n11	**n1-n2-n5-n6-n10**	Yes	0,67
4	[n1-n2-n5-n6-n10-n14-n6-n3-n2-n4-n4-n9-n13-n13-n12-n11	No route found	No	0,231
5	n1-n3-n5-n5-n16-n12-n13-n14-n5-n5-n2-n4-n4-n4-n8-n8	No route found	No	0,183
6	**n1-n3-n7-n11**-n9-n10-n15-n8-n12-n13-n14-n4-n5-n14-n13-n12	**n1-n3-n7-n11**	Yes	0,523
7	**n1-n2- n4-n8-n10**-n14-n11-n15-n9-n4-n8-n12-n14-n11-n10-n13	**n1-n2-n4-n8-n10**	Yes	0,896
8	**n1-n2- n4-n8**-n10-n14-n11-n15-n9-n3-n7-n12-n13-n11-n7-n10	**n1-n2-n4-n8-n10**	Yes	0,896
9	n1-n3-n13-n14-n14-n5-n5-n5-n2-n4-n4-n8-n13-n14-n13-n10	No route found	No	0,212
10	**n1-n2-n5-n6-n10**-n14-n6-n3-n2-n4-n4-n9-n13-n13-n12-n11	**n1-n2-n5-n6-n10**	Yes	0,67

B. Two-Point Crossover

Two-point crossover method uses two exchange positions in the parent individual to produce a new individual. The exchange positions are determined by generating random numbers. Table IV shows the testing trials of the *two-point crossover*. There are 7 out of 10 trials produce valid route with the highest fitness value of *0.896.*

TABLE IV. TESTING RESULT for *TWO-POINT CROSSOVER*

Trials	Optimal Chromosomes	Valid Route	Validity	Fitness value
1	**n1-n3-n7-n11**-n9-n10-n13-n11-n14n9-n6-n15-n4-n14-n8-n13-n10-n9	**n1-n3-n7-n11**	Yes	0,529
2	**n1-n2-n4-n8-n10**-n16-n6-n3-n12-n15-n9-n4-n2-n5-n14-n8-n4-n3	**n1-n2-n4-n8-n10**	Yes	0,896
3	**n1-n2-n5-n6-n10**-n13-n14-n13-n14-n14-n11-n14-n13-n13-n14-n13-n12-n2	**n1-n2-n5-n6-n10**	Yes	0,69
4	n1-n14-n11-n14-n14-n13-n14-n14-n14-n13-n14-n13-n14-n14-n13-n14-n14-n14	No route found	No	0,361
5	**n1-n2-n4-n5-n6-n10**-n10-n13-n12-n13-n8-n9-n10-n5-n13-n15-n16-n5	**n1-n2-n4-n5-n6-n10**	Yes	0,638
6	n1-n2-n4-n4-n8-n13-n14-n13-n14-n14-n13-n14-n14-n14-n14-n14-n14-n14	No route found	No	0,367
7	**n1-n2-n4-n8-n9-n12-n16**-n4-n5-n2-n5-n13-n14-n13-n5-n13-n10-n7	**n1-n2-n4-n8-n9-n12-n16**	Yes	0,467
8	**n1-n2-n4-n8-n10**-n11-n12-n3-n12-n15-n7-n8-n6-n5-n13-n8-n4-n15	**n1-n2-n4-n8-n10**	Yes	0,896
9	**n1-n2-n4-n8-n10**-n2-n5-n9-n11-n8-n7-n9-n13-n3-n16-n7-n3-n11	**n1-n2-n4-n8-n10**	Yes	0,896
10	n1-n2-n11-n14-n13-n14-n14-n14-n11-n14-n13-n14-n13-n14-n14-n13-n14-n13	No route found	No	0,343

C. Uniform Crossover

Uniform crossover is a crossover operator that performs recombination selectively and consider as the most effective crossover method [17]. This crossover method swaps the position of each parent individual according to predefined probability level in producing a new individual. Out of 10 trials conducted for *uniform crossover* as shown in Table V, only 1 route was invalid. In addition, among 8 of 9 success trials give extremely high fitness value, that is 0.896. This result confirmed the *uniform crossover* as the most effective crossover method.

TABLE V. TESTING RESULT for *UNIFORM CROSSOVER*

Trials	Optimal Chromosomes	Valid Route	Validity	Fitness value
1	**n1-n2-n4-n8-n10**-n4-n12-n15-n2-n13-n9-n16-n7-n10-n15-n3	**n1-n2-n4-n8-n10**	Yes	0,896
2	n1-n2-n4-n8-n8-n4-n5-n16-n15-n13-n14-n13-n14-n14-n13-n12	No route found	No	0,259
3	**n1-n2-n4-n8-n10**-n4-n12-n15-n2-n14-n6-n16-n3-n10-n15-n12	**n1-n2-n4-n8-n10**	Yes	0,896
4	**n1-n2- n4-n8-n10**-n14-n11-n15-n9-n4-n8-n12-n14-n11-n7-n19	**n1-n2-n4-n8-n10**	Yes	0,896
5	**n1-n2- n4-n8-n10**-n14-n11-n15-n9-n4-n8-n12-n14-n11-n7-n10	**n1-n2-n4-n8-n10**	Yes	0,896
6	**n1-n3-n7-n11**-n10-n16-n15-n5-n12-n10-n14-n4-n2-n14-n8-n12	**n1-n3-n7-n11**	Yes	0,523
7	**n1-n2-n4-n8-n10**-n4-n12-n15-n2-n13-n9-n16-n6-n10-n15-n12	**n1-n2-n4-n8-n10**	Yes	0,896
8	**n1-n2-n4-n8-n10**-n4-n12-n15-n2-n14-n6-n16-n3-n10-n15-n12	**n1-n2-n4-n8-n10**	Yes	0,896
9	**n1-n2- n4-n8-n10**-n14-n11-n15-n9-n4-n8-n12-n14-n11-n6-n7	**n1-n2-n4-n8-n10**	Yes	0,896
10	**n1-n2- n4-n8**-n10-n14-n11-n15-n9-n4-n8-n12-n14-n11-n7-n10	**n1-n2-n4-n8-n10**	Yes	0,896

IV. CONCLUSION

Based on the testing result, the best crossover method of the genetic algorithm in optimizing the recommended flood evacuation routes is the *uniform crossover.* This method gives 90% for valid routes and 0.896 for the fitness values. Meanwhile, *two-point crossovers* only produce 70% valid routes of 70% and one-point crossovers of 60%. This result confirmed the statement of previous research [17] which convinced that the *uniform crossover* is the most effective crossover method among others.

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REFERENCES

[1] BNPB: Badan Nasional Penanggulangan Bencana, "Geoportal Data Bencana Indonesia," *bnpb.go.id*, 2022. https://gis.bnpb.go.id/

[2] J. Inovasi Penelitian, O. Eldi Widyaiswara Kementerian Agraria dan Tata Ruang, B. Pertanahan Nasional Jl Sisingamangaraja No, K. Kby Baru, K. Jakarta Selatan, and D. Khusus, "Analisis Penyebab Banjir Di DKI Jakarta," *J. Inov. Penelit.*, vol. 1, no. 6, pp. 1057–1064, Oct. 2020, doi: 10.47492/JIP.V1I6.203.

[3] R. Harahap, "Pekerjaan Drainase Dan Penyebab Banjir Lingkungan Permukiman," *Semin. Nas. Tek. UISU*, vol. 2, no. 1, pp. 5–9, May 2019.

[4] A. Fauzia, D. A. Pawestri, U. Wahrudin, S. N. Rahmawati, S. Himayah, and N. Nandi, "Analisis Penentuan Lokasi Evakuasi Bencana Banjir Dengan Sistem Informasi Geografis Dan Metode Simple Additive Wighting (Studi Kasus Kecamatan Cileungsi)," *J. Pendidik. Geogr. Undiksha*, vol. 9, no. 2, pp. 121–132, Aug. 2021, doi: 10.23887/JJPG.V9I2.35305.

[5] I. F. R, Y. Prihanto, and S. Martha, "Pendekatan Sistem Fuzzy Dalam Penentuan Kelayakan Rute Evakuasi Bencana Banjir Berbasis Sistem Informasi Geografis," *Teknol. Penginderaan*, vol. 2, no. 2, Dec. 2020.

[6] Y. Pratiwi, C. Dewi, and E. Rahmadi, "Analisis Penentuan Kawasan Rawan Banjir Untuk Menentukan Sebaran Titik Dan Rute Evakuasi Di Kawasan Perkotaan Kabupaten Lampung Utara," *J. Geod. Geomatics*, vol. 2, no. 01, pp. 52–58, Jun. 2022.

[7] S. M. Almufti, A. Yahya Zebari, and H. Khalid Omer, "A comparative study of particle swarm optimization and genetic algorithm," *J. Adv. Comput. Sci. Technol.*, vol. 8, no. 2, pp. 40–45, 2019.

[8] T. S. Delwar, A. Siddique, P. K. Pradhan, A. Jana, and J. Y. Ryu, "Signal power optimization technique in optical wireless link: a comparative study with GA and PSO," *Opt. Quantum Electron. 2021*, vol. 53, no. 8, pp. 1–19, Aug. 2021, doi: 10.1007/S11082-021-03085-6.

[9] E. Hertnacahyani Herraprastanti, H. Gunawan, and B. Santoso, "Studi Komparasi Optimasi Particle Swarm Dan Algoritma Genetika Pada Perancangan Foil," *J-Ensitec*, vol. 05, no. 02, pp. 282–290, 2019.

[10] S. Mauluddin, I. Ikbal, and A. Nursikuwagus, "Optimasi Aplikasi Penjadwalan Kuliah Menggunakan Algoritma Genetik," *J. RESTI (Rekayasa Sist. dan Teknol. Informasi)*, vol. 2, no. 3, pp. 792–799, Dec. 2018, doi: 10.29207/RESTI.V2I3.597.

[11] I. Hidayat, S. Revo, L. Inkiriwang, and P. A. K. Pratasis, "Optimasi Penjadwalan Menggunakan Metode Algoritma Genetika Pada Proyek Rehabilitasi Puskesmas Minanga," *J. Sipil Statik*, vol. 7, no. 12, pp. 1669–1680, Dec. 2019.

[12] A. Assagaf, A. Ibrahim, and C. Suranto, "Membangun Sistem Informasi Penjadwalan Dengan Metode Algoritma Genetika Pada Laboratorium Teknik Informatika Universitas Muhammadiyah Maluku Utara," *J. Ilm. Ilk. - Ilmu Komput. Inform.*, vol. 1, no. 2, pp. 95–105, Jul. 2018, doi: 10.47324/ILKOMINFO.V1I2.13.

[13] L. A. Zahir, "Algoritma Genetika Sebagai Solusi Permasalahan Persamaan Linear Matematika," *J. Res. Sci. Math. Educ.*, vol. 1, no. 2, pp. 87–95, Nov. 2022, doi: 10.56855/JRSME.V1I2.62.

[14] A. Fanggidae and J. I. Komputer, "Analisis Metode Single-Point Crossover (SPX), Two-Point Crossover (TPX) Dan Multi-Point Crossover (MPX) Pada Fungsi Nonlinear Dua Peubah Dengan Binary Coding," *J-ICON J. Komput. dan Inform.*, vol. 7, no. 1, pp. 17–20, Mar. 2019, doi: 10.35508/JICON.V7I1.872.

[15] S. Katoch, S. S. Chauhan, and V. Kumar, "A review on genetic algorithm: past, present, and future," *Multimed. Tools Appl.*, vol. 80, no. 5, pp. 8091–8126, Feb. 2021, doi: 10.1007/S11042-020-10139-6/FIGURES/8.

[16] R. Imam Tarecha, and Y. Riyanto, "Menyesuaikan Tingkat Kesulitan Permainan menggunakan Algoritma Genetika dengan Shanon-Wiener Diversity Index sebagai Dasar Pengambilan Keputusan untuk Menginterupsi Konvergensi Prematur," *CogITo Smart J.*, vol. 5, no. 2, pp. 137–147, Dec. 2019, doi: 10.31154/COGITO.V5I2.185.137-147.

[17] E. Sanggala and S. Khamdani, "Penyelesaian Traveling Salesman Problem Dengan Metode Algoritma Genetika (Uniform Crossover)," *J. Logistik Bisnis*, vol. 12, no. 1, pp. 51–55, May 2022.

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