Comparison of BFS and DFS Algorithm for Routes to Historical-Cultural Tourism Locations in Banten Province

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ABSTRACT

The development of information technology has had a significant impact on the tourism sector, especially in enriching the tourist experience, especially in the field of historical and cultural tourism. With its wealth of historical tourist attractions, Banten Province is a significant destination for tourists who want to explore and understand cultural and historical values in Indonesia. This research aims to maximize tourists' experience in visiting historical-cultural tourist attraction locations in Banten Province by choosing optimal travel routes, thereby increasing visit efficiency, minimizing travel time and distance, and enabling them to see more locations in a limited time. In this research, the method used is research with a quantitative descriptive approach and graphic model design. The simulation and testing results of the graph model were analyzed for the selection of tourist travel routes using the Breadth-First Search (BFS) and Depth-First Search (DFS) algorithms based on graph models that describe the location of cultural-tourism objects. The simulation results show that BFS tends to produce travel routes that are more efficient in terms of distance traveled, while DFS optimizes the number of tourist site visits by exploring routes in depth. This research provides insight into these two approaches and their implications for travel decision-making.

1. Introduction

The development of information technology has brought significant changes in various fields, including tourism. Historical and cultural tourism is a critical aspect of tourism, offering and providing tourists with experiences regarding an area's historical and cultural heritage [1]. Banten Province is one of the provinces with historical archaeological locations or objects in Indonesia [2]. It has become the leading alternative destination for tourists to explore historical places and learn about cultures that have historical value in the past. Optimizing visits for tourists to historical-cultural tourist locations in Banten Province is very important to improve the experience for the tourists themselves. Therefore, information technology can be essential to determine optimal travel routes, primarily through graph search algorithms. Algorithms such as Breadth-First Search (BFS) and Depth-First Search (DFS) are often used to find the shortest or most optimal path in a network of locations.

Determining the optimal route to the location of archaeological tourist attractions in Banten Province has several essential benefits [3]. First, tourists can explore several locations more efficiently, reducing confusion due to the many tourist locations that must be visited in several districts or sub-districts. Second, this algorithm can help optimize travel routes so that tourists can determine how many historical-cultural tourist attraction locations they will see. This is very important for tourists with limited visiting time who want to maximize their experience. In addition, graph search algorithms can increase added value for tourists' historical knowledge. With structured and optimized routes, tourists can focus on learning and appreciating the historical information presented at each location. This technology also allows archaeological site managers to provide more informative and interactive travel guides using technology-based applications that provide additional historical information, interactive maps, and recommendations for the best routes.

Thus, integrating information technology in the form of a graph search algorithm makes access and navigation easier in determining the location of historical-cultural tourist attractions in Banten Province and enriches the educational experience for tourists. This shows that technology can play an essential role in the preservation and understanding of cultural heritage, making history more accessible and more enjoyable for current and future generations. This implementation increases the efficiency of visits and ensures that each visit is a comprehensive and meaningful learning experience.

The BFS algorithm in finding optimal paths, especially in the tourism sector, has been implemented by several researchers, for example, research conducted by Yosdarso Afero in 2022 entitled "BFS Algorithm Determines the Shortest Path in the Tourist City of Bukittinggi." This research showed that the BFS algorithm can effectively determine the shortest and most efficient route for tourists visiting various attractions in Bukittinggi City. These results show that the algorithm can optimize travel time and distance and provide a more structured and efficient tourism experience [4]. Meanwhile, research conducted by Julian Sahertian et al. in 2020 applied the DFS algorithm in the tourism sector. This implementation is implemented in an Android-based tourism scheduling system in Trenggalek Regency to support smart cities. The application system was successfully implemented based on the black box functional test results, making it easier for tourists to schedule tours, especially in Trenggalek Regency [5].

Apart from finding optimal travel routes, the BFS and DFS algorithms can also be implemented in several cases in building an information system; for example, research conducted by Yuliana et al. in 2024 entitled "Implementation of the DFS-BFS Algorithm in Accreditation Documents," the results of the study can contribute to increasing the speed and efficiency of searching for accreditation documents. In addition, by implementing a hybrid technique of the two algorithms, the system can provide an effective solution in finding accreditation document storage paths quickly and efficiently by the specific objectives set [6].

The fundamental difference between this research and previous research based on the literature review above is in the geographical focus and object of study. This research focuses on the locations of historical-cultural tourist attractions in Banten Province. Apart from that, this research will compare the performance of the two algorithms in the same case, namely determining the optimal route to historical-cultural tourist locations. It is hoped that it will provide more comprehensive insight into the strengths and weaknesses of each algorithm [7]. By simulating and comparing the two algorithms, this research hopes to become a reference for implementation in other fields and provide practical information about the application of the BFS and DFS algorithms in optimizing travel routes to historical-cultural tourist attraction locations, especially in Banten Province.

2. Methods

The research method used is a quantitative approach with a simulation experimental design [8]. This research began with collecting geographic data on the distribution of historical-cultural tourist locations in Banten Province and other relevant information [9]. Next, model a graph that represents a network of locations, especially between sub-districts and districts, where each node represents the location of a tourist attraction and each edge represents the road that connects to that location [10]. Simulations were carried out to test the two algorithms in various search scenarios. This was done to compare the number of tourist attractions that can be visited and the distance between sub-district locations. The results of each simulation are recorded, including total distance traveled and route efficiency. The simulation data is analyzed to determine the performance of each algorithm and find significant differences [11]. The research results are presented in Table form and visualized through an interface design implemented using the PHP programming language [12]. Figure 1 shows the stages of the research carried out.

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Figure 1. Research Stages

1. Data Collections: Collecting data covering the distribution of tourist attractions in Banten Province and the distribution of sub-district names based on the division of district areas in Banten Province.
2. Graph Model Simulation Design: Designing a graph model based on the results of data collection and conducting simulations using the BFS and DFS algorithms.
3. Analysis: Conduct a comparison of the two algorithms so that their advantages and disadvantages can be identified based on the cases tested.

3. Results and Discussions

3.1. Data Collection

Data was collected using field observations at several government agencies or halls in Banten Province, including the Tourism Office and the Center for Cultural Heritage Conservation. In addition to collecting primary data, literature studies were carried out to identify several reference sources, which are part of secondary data collection, to support the accuracy of data collection [13]. The following is the number of historical-cultural tours spread across several Banten Province districts, as seen in Table 1 [14]:

Table 1. Distribution of Historical-Cultural Tourism in Banten Province

City/Regency	Museum	Archaeological Site	Historical Building
Tangerang Selatan	-	1	3
Tangerang Kota	-	2	9
Tangerang Kabupaten	-	6	6
Serang Kabupten	-	4	2
Serang Kota	3	48	39
Kota Cilegon	4	3	3
Lebak	1	4	10
Pandeglang	1	9	17
Amount	**9**	**77**	**89**

Table 1 above shows that the districts with the most extensive distribution of historical-cultural tourism locations are Serang City, Pandeglang Regency, and Lebak Regency. After obtaining data on the distribution of cultural tourism in several districts/cities, the researcher identified the sub-district areas per district/city; this is important to recognize because it is a simulation for tracing travel routes that will be modeled in graphs. The results of the identification of data collection can be seen in several Tables below.

Table 2 below represents the division of sub-districts in Serang Regency into three central regions. Region I includes the sub-districts of Cikande, Kibin, Binuang, Carenang, Kragilan, Ciruas, Lebak Wangi, Pontang, Tirtayasa, and Tanara. Region II consists of Kopo, Jawilan, Pamarayan, Bandung, Cikeusal, Tunjung Teja, Petir, Ciomas, and Padarincang. Meanwhile, Region III covers the sub-districts of Baros, Waringin Kurung, Pabuaran, Anyer, Gunung Sari, Mancak, Pulo Ampel, Kramat Watu, Cinangka, and Bojonegara. Below is the data on the administrative distribution of the regions in Serang Regency.

Table 2. Sub Districts – Serang Regency

Region-1	Region-2	Region-3
Cikande	Kopo	Baros
Kibin	Jawilan	Warigin Kurung
Binuang	Pamarayan	Pabuaran
Carenang	Bandung	Anyer

Region-1	**Region-2**	**Region-3**
Kragilan	Cikeusal	Gunung Sari
Ciruas	Tunjung Teja	Mancak
Lebak Wangi	Petir	Pulo Ampel
Pontang	Ciomas	Kramat Watu
Tirtayasa	Cinangka	Bojonegara
Tanara	Padarincang	-

Source: Badan Pendapatan Daerah Kabupaten Serang (http://bapenda.serangkab.go.id/)

Table 3 below contains a list of sub-districts in Serang City. These sub-districts include Kota Serang, Serang, Cipocok Jaya, Walantaka, Curug, Taktakan, and Kasemen. This Table is sourced from the official Serang City Statistics Agency, which provides comprehensive information about the city's administrative divisions.

Table 3. Sub Districts – Serang City

Sub-Districts	**Sub-Districts**
Kota Serang	Curug
Serang	Taktakan
Cipocok Jaya	Kasemen
Walantaka	-

Source: Badan Statistik Kota Serang (https://serangkota.bps.go.id/)

Table 4 below contains a list of 28 districts in Tangerang Regency. In this simulation route, only Kronjo and Mekar Baru Districts were passed in the northern area. In the western part, the route includes Jayanti, Sukamulya, Kresek, and Gunung Kaler Districts, while in the southern area, the route covers Cisoka and Solear Districts.

Table 4. Sub Districts – Tangerang Regency

Sub-Districts	**Sub-Districts**	**Sub-Districts**
Cikupa	Tigaraksa	Rajeg
Balaraja	Panongan	Mauk
Cisoka	Jambe	Sepatan
Solear	Curug	Sepatan Timur
Jayanti	Kelapa Dua	Pakuhaji
Sukamulya	Cisauk	Sukadiri
Kresek	Legok	Teluk Naga
Gunung Kaler	Pagedangan	Kosambi
Mekar Baru	Sindang Jaya	-
Kronjo	Pasar Kemis	-

Source: Badan Statistik Kabupaten Tangerang (https://opendata.tangerangkab.go.id/infographic)

In this route tracing simulation, not all sub-districts in the regencies/cities listed in the tables above were passed through during the test simulation. Because the starting point of the simulation was the Balaraja District, some sub-districts that were not passed through were Petir, Ciomas, Cinangka, Padarincang, Warung Gunung, Pabuaran, Anyer, Gunung Sari, Mancak, Pulo Ampel, Kramat Watu, Bojonegara, Serang, Tigaraksa, Panongan, Jambe, Curug, Kelapa Dua, Cisauk, Legok, Pagedangan, Sindang Jaya, Pasar Kemis, Rajeg, Mauk, Sepatan, East Sepatan, Pakuhaji, Sukadiri, Teluk Naga, Kosambi. Meanwhile, in the Lebak Regency area, only Rangkas District was passed through on the travel route. South Tangerang City and Tangerang City are not included in the scope of this simulation discussion. Figure 3 below shows a map representing the division of sub-districts in regencies/cities in Banten Province.

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Figure 2. Map of Sub-district Distribution in Banten Province

3.2. Graf Model Design

After the data collection stage is carried out, the next step is to design the graph model. Before carrying out a comparative analysis of the two algorithms, the researcher made an analysis that describes the distance traveled between travel routes from each cultural tourist attraction spread across several sub-districts. The graph model shown in Figure 3 below is the initial state and final state so that it can describe the travel route to the final location point (goal state) and the number of tourist objects that can be visited [15].

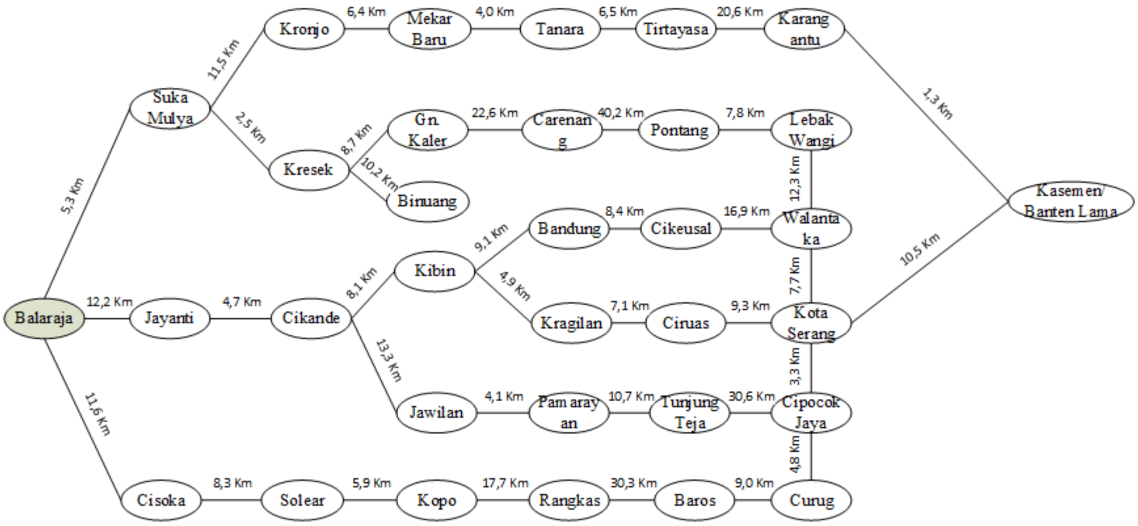

Figure 3. Graf Model Design

From the graph model above, if it is mapped and compared by tracing the three main routes from the initial state, namely from the south, west, and north directions, where all travel route directions are tested by calculating the distance traveled, it can be summarized as shown in Table 5 below:

Table 5. Travel Route

Direction	Travel Path	Mileage (kilometers)
North	Balaraja-Sukamulya-Kronjo-Mekar Baru-Tanara-Tirtayasa-Karangantu - Banten Lama	55.6
North	Balaraja-Sukamulya-Kresek-Gunung Kaler-Carenang-Pontang-Lebak Wangi-Walantaka-Serang Kota-Banten Lama	117.6
West	Balaraja-Jayanti-Cikande-Kibin-Bandung-Cikuesal-Walantaka-Serang Kota-Banten Lama	77.6
West	Balaraja-Jayanti-Cikande-Kibin-Kragilan-Ciruas-Serang Kota-Banten Lama	56.8

Direction	Travel Path	Mileage (kilometers)
West	Balaraja-Jayanti-Cikande-Jawilan-Pamarayan-Tunjung Teja-Cipocok Jaya-Serang Kota – Banten Lama	89.4
South	Balaraja-Cisoka-Solear-Kopo-Rangkas-Baros-Curug-Cipocok Jaya-Serang Kota-Banten Lama	101.4

3.3. Simulation and Testing

Based on Figure 2 and Table 5 above, if a search is carried out using the BFS algorithm with the assumption that the initial state and final state are the same, and a test simulation is carried out from the three main route directions, the following conclusions can be drawn:

1. If tourists choose the option via the northern route, there are two travel routes with different travel distance ratios, namely, the distance of the first travel route is 55.6 km, and the distance of the second is 117.6 kilometers. Where both travel routes have their respective advantages and disadvantages. The distance traveled on the first route is smaller than on the second route, but the number of tourist locations is smaller than on the second route. It can be seen from Table 1 that the distribution of locations of most cultural tourism objects is in the Serang City Regency.
2. If tourists choose to travel in the western direction, there are three routes they can choose; these three routes have similarities in optimizing the number of tourist locations that can be visited but have differences in travel distance, namely 77.6 kilometers and 56.8 kilometers, respectively. and 89.4 kilometers.
3. In the BFS algorithm search, the southern route does not have a travel route that connects directly to the goal state location because the direction of this route must pass through the edge of the network that the western route has visited. However, if tourists choose to travel in this direction, they must take a travel route with a distance of 101.4 kilometers. Even though the distance is longer, tourists can maximize the number of visits to historical-cultural tourist locations. The southbound travel route passes through a sub-district in Lebak Regency, which has additional visiting locations besides Serang City.

The BFS algorithm search will only stop if one direction of the travel route has found its goal state after considering the distance traveled or the distribution of tourist attraction locations on each travel route. Figure 3 below is one of the optimal paths for tracing travel routes using the BFS algorithm.

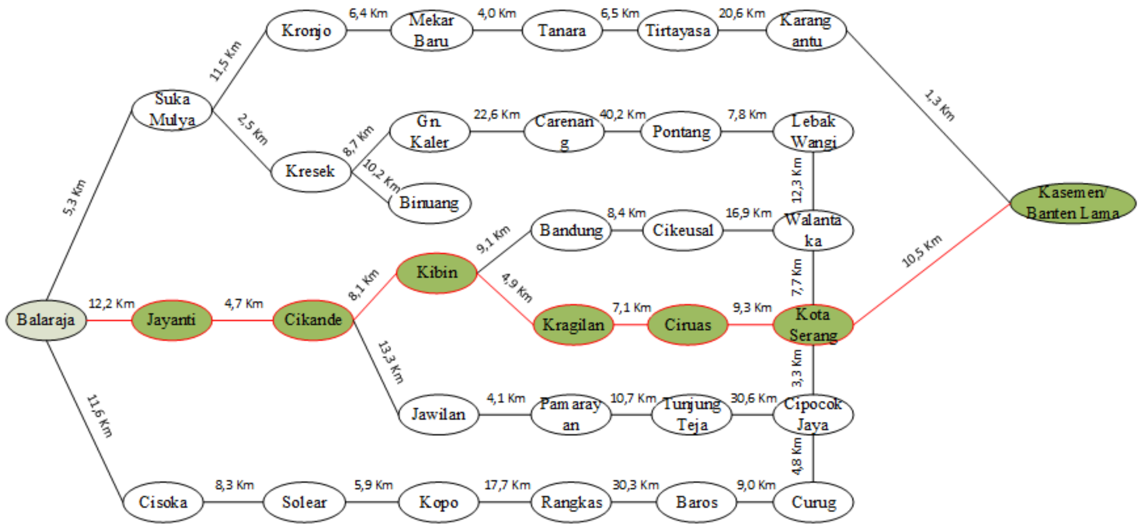

Figure 4. Graf Model Design BFS Algorithm

Meanwhile, suppose the graph model from Figure 2 and Table 5 above is mapped and searched using the DFS algorithm, assuming the initial and final states and test simulations are the same as using the BFS algorithm. In that case, the following conclusions can be drawn:

1. If tourists choose the option via the northern route, the wrong path will lead to the goal state with a distance of 55.6 kilometers. However, there are better routes than this regarding the number of

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visits and distribution of historical-cultural tourist locations. Suppose the travel route traces or searches at the network's edge that connects sub-district locations with the same goal state, from Tirtayasa to Pontang, to optimize the number of tourist visit locations. In that case, the distance that must be traveled is 77.7 kilometers. Likewise, if you search and look for the edge of other location networks, the distance traveled is still more remarkable.

2. If tourists choose to travel with the Western option, the three routes can optimize the number of visiting locations with different travel distances. Still, if two of the three routes return to the edge of the previous network, which connects sub-district locations to find the shortest travel distance, the travel route will be longer. Of course, the distance traveled is greater. Searching the DFS algorithm for the west direction will be optimal if it only searches one of the correct travel routes, in this case, via the Kibin-Kragilan-Ciruas-Kota Serang.
3. Furthermore, if tourists choose the southern route, there is only one route with a total distance of 101.4 kilometers. Suppose tourists will search for or return to the edge of the previous network that connects locations between sub-districts to find the shortest distance. In that case, the travel route will have a longer distance and will not necessarily be able to optimize the number of visits to tourist locations.

The DFS algorithm will map and trace between one location or sub-district and another sub-district until it finds the goal state before returning to the previous edge of the network. Figure 4 below is a search using the DFS algorithm, which uses one example of a path or direction from the three directions that can be used.

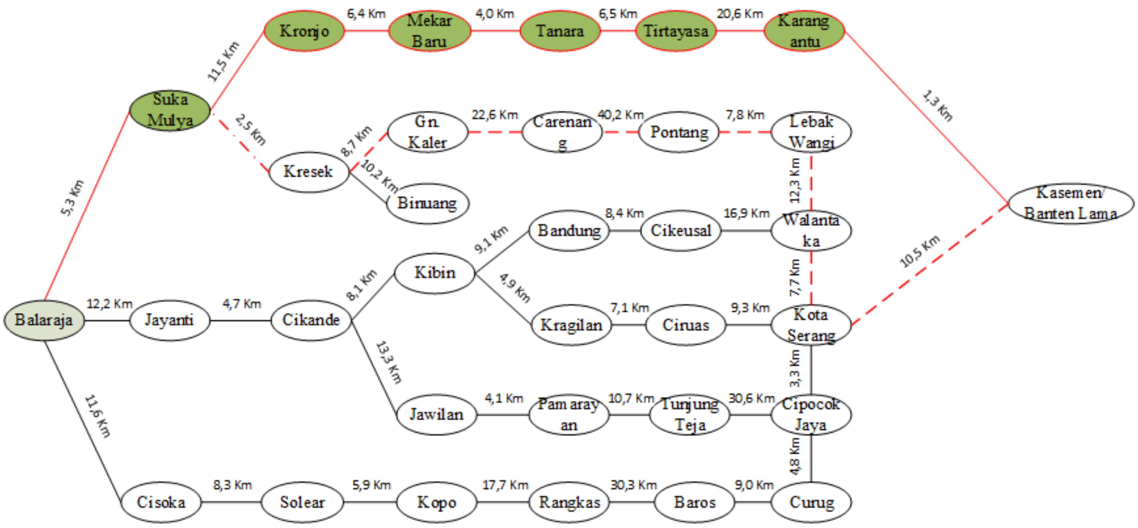

Figure 5. Graf Model Design DFS Algorithm

4. Conclusion

From the analysis using the BFS algorithm, it can be concluded that this travel route search tends to be more efficient regarding distance traveled by prioritizing exploration to nearby locations or sub-districts first before expanding the search to more distant locations. This results in relatively short travel routes but will only sometimes get optimal value in the number of visits to tourist locations because it depends on which direction the search will start. Meanwhile, the DFS algorithm tends to explore one path in depth, namely exploring travel routes that may be longer but can produce more varied, optimal results regarding the number of visits to several tourist locations. This DFS algorithm effectively describes a better approach to exploring travel options, especially in optimizing the number of visit locations, but is not necessarily the best choice in terms of distance efficiency or optimal travel because this algorithm will explore every possible path thoroughly before reaching the goal state or returning to the network node that connects the previous network edge. In mapping and tracing the graph model for the case in this study, the BFS algorithm provides advantages in terms of distance efficiency and optimization of the number of visit locations. In contrast, the DFS algorithm offers greater flexibility in optimizing the number of visits to tourist locations. Therefore, the choice between the two algorithms should be based on individual priorities regarding factors such as distance traveled and number of locations visited.

References

[1] D. Negri Wijaya, I. Lutfi, R. R. Hudiyanto, D. Y. Wahyudi, and F. Ariska, "Daya Tarik Wisata sejarah budaya di Malang," *HISTORIOGRAPHY: Journal of Indonesia History and Education*, vol. 2, no. 3, pp. 1–15, 2022.

[2] S. Rusmeijani, *Museum Situs Kepurbakalaan Banten Lama*. 2019. Accessed: May 04, 2024. [Online]. Available: https://repositori.kemdikbud.go.id/25737/1/Booklet%20MSKBL.pdf

[3] W. L. Putri and N. Jarti, "Algoritma General and Test Menggunakan Metode Depth First Search Dalam Penentuan Jalur Rute Terpendek," *BRAHMANA: Jurnal Penerapan Kecerdasn Buatan*, vol. 4, no. 2, pp. 154–163, 2023.

[4] Y. Afero, "Algoritma Best First Search Menentukan Lintasan Jalur Terpendek Pada Kota Wisata Bukittinggi," *JOISIE Journal Of Information System And Informatics Engineering*, vol. 5, no. Desember, pp. 138–145, 2021.

[5] J. Sahertian, M. Ayu, D. Widyadara, and F. Rega Agista, "Implementasi Sistem Penjadwalan Wisata Di Kabupaten Trenggalek Berbasis Android Untuk Menunjang Smart City," *JOUTICA*, vol. 5, no. 1, pp. 326–330, 2020.

[6] Yuliana and M. Qulub, "Implementasi Algoritma Depth-First Search dan Breadth-First Search Pada Dokumen Akreditasi," *Journal of Science and Social Research*, vol. VII, no. 1, pp. 197–204, 2024, [Online]. Available: http://jurnal.goretanpena.com/index.php/JSSR

[7] Hindarto, Sumarno, and R. Mochammad Alfan, *Buku Ajar Kecerdasan Buatan/Artificial Intelegent (AI)*, Pertama., vol. 978-623-464-034–2. UMSIDA Press, 2022. Accessed: May 04, 2024. [Online]. Available: https://press.umsida.ac.id/index.php/umsidapress/article/view/1306

[8] E. Sumantri and S. Hidayattullah, "Penerapan Algoritma A*Star Untuk Mencari Rute Terpendek Dari Kemayoran Ke Destinasi Monumen Nasional (MONAS)," *Jurnal Sains dan Teknologi*, vol. 5, no. 2, pp. 673–680, 2023, doi: 10.55338/saintek.v5i1.1432.

[9] M. Pratami, R. Harianja, and W. Agung Sadewo, "Persebaran Objek Wisata Dengan Sistem Informasi Geografi (SIG) Kabupaten Lampung Barat," *Journal of Science, Technology, and Virtual Culture*, vol. 1, no. 2, pp. 118–123, 2021.

[10] N. I. Sriyanto, F. A. Maulana, R. Aprilian, E. Christian, and V. H. Pranatawijaya, "Utilisation of A Star Algorithm in Determining Tourism Routes in Palangka Raya City," *Telekontran : Jurnal Ilmiah Telekomunikasi, Kendali dan Elektronika Terapan*, vol. 12, no. 1, pp. 23–37, May 2024, doi: 10.34010/telekontran.v12i1.12645.

[11] A. Muhardono, "Penerapan Algoritma Breadth First Search dan Depth First Search pada Game Angka," *Jurnal Minfo Polgan*, vol. 12, no. 1, pp. 171–182, Mar. 2023, doi: 10.33395/jmp.v12i1.12340.

[12] V. A. Flores, P. A. Permatasari, and L. Jasa, "Penerapan Web Scraping Sebagai Media Pencarian dan Menyimpan Artikel Ilmiah Secara Otomatis Berdasarkan Keyword," *Majalah Ilmiah Teknologi Elektro*, vol. 19, no. 2, p. 157, Dec. 2020, doi: 10.24843/mite.2020.v19i02.p06.

[13] S. C. Nurzanah, S. Alam, and T. I. Hermanto, "Analissi Association Rule Untuk Identifikasi Pola Gejala Penyakit Hipertensi Menggunakan Algoritma APRIORI (Studi Kasus: Klinik Rafina Medical Center)," *Jurnal Informatika dan Komputer)*, vol. 5, no. 2, pp. 132–141, 2022, doi: 10.33387/jiko.

 DOI: https://doi.org/10.52435/jaiit.v6i2.560

[14] H. Anisah, I. Nurhafifah, I. Fitrian, E. Utari, and I. Rifqiawati, “Banten Lama sebagai Daya Tarik Wisata Bersejarah di Kabupaten Serang,” *Jurnal Dinamika Sosial Budaya*, vol. 25, no. 2, pp. 67–75, 2023, [Online]. Available: https://journals.usm.ac.id/index.php/jdsb

[15] T. S. Faritcan Parlaungan and I. Tugimin, “Perancangan Perangkat Lunak Pencarian Solusi Permasalahan Teko Air (Waterjug Problem) Menggunakan Algoritma Breadth First Seacrh (BFS),” *Jurnal Teknologi Informasi STMIK Subang dan Komunikasi*, vol. ISSN: 2252-4517, pp. 1–16, 2022.

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