*Comparison Analysis of Best First Search Algorithm with A * (star) in determining the closest route in the district Sleman*

Tutik Maryana*[1], Ripto Sudiyarno[2] , Kusrini[3]
[1,2,3]Magister Teknik Informatika, Fakultas Ilmu Komputer, Universitas Amikom Yogyakarta
E-mail: *[1]**tutik.maryana@students.amikom.ac.id**, [2]**ripto@students.amikom.ac.id**, [3]**kusrini@amikom.ac.id**

Abstrak

Terdapat bermacam-macam algoritma pathfinding yang memiliki kekurangan dan kelebihan masing-masirg algoritma. Tujuan dari penelitian ini adalah untuk membandingkan algoritma pathfinding greedy best-first search dengan A(Star) dalam hal menentukan rute terpendek dalam pencarian tentor di Kab. Sleman, Yogyakarta. Metode yangdigunakan dalam penelitian ini adalah metode analisis untuk menganalisis algoritma apa saja yang dapat diterapkan dalam pencarian lintasan. Kemudian, metode dilanjutkan dengan metode perancangan terhadap algoritma greedy best-first search dan A* (star),tampilan antar muka pada aplikasi pengujian algoritma. Metode selanjutnya adalah metode implementasi, yaitu algaritma greedy best-first search dan A* (star) diimplementasikan ke aplikasi pengujian algoritma. Metode terakhir adalah metode pengujian terhadap algoritma yang akan dibandingkan Simpulan akan ditarik dari hasil perbandingan algoritma. Hasil dani penelitian ini adalah perolehan perbandingan jarak antara algoritma greedy best-first search dengan A*, Kesimpulan dari penelitian ini adalah algoritma A* mampu memberikan hasil rute terpendek dan optimal dibanding algoritma BFS dalam proses pencarian mentor pada aplikasi lesprivate.id di area Kab. Sleman.*

Kata Kunci: *algoritma pathfinding, best-first search, A*(Star), rute terpendek, pencarian tentor*

Abstract

*There are various pathfinding algorithms that have advantages and disadvantages of each algorithm. The purpose of this study is to compare the best-first search pathfinding greedy algorithm with A * (Star) in terms of determining the shortest route in a tent search. The method used in this study is an analytical method for analyzing what algorithms can be applied in track search. Then, the method continued with the design method for the best-first search and A * greedy algorithm, the user interface for the algorithm testing application. The next method is the implementation method, which is the best-first greedy algarithm search and A * implemented in the algorithm testing application. The last method is the method of testing algorithms that will be compared. The conclusions will be drawn from the results of comparison algorithms. The result of this study is the acquisition of a distance comparison between the greedy best-first search algorithm with A *. The conclusion of this study is that the A * algorithm is able to provide the shortest and optimal route results compared to the BFS algorithm.*

Keywords : *pathfinding algorithm, best-first search, A * (Star), shortest route, tentor search*

1. INTRODUCTION

In this modern era, maps are still used by most people to get to a place. The path chosen to get to the destination must be the shortest path. However, searching for the shortest path manually, will require a lot of time and accuracy. The shortest path problem is related to finding a path on a weighted graph that connects two vertices (edges) such that the sum of the weights on the selected sides is the minimum weight. There are many algorithms that can be used to solve problems in finding the shortest path k. The selection of the most optimal algorithm is often a problem in finding the shortest path because each algorithm has advantages and disadvantages of each [1]. There are several search algorithms to find the shortest distance search solution, including the breadth first search algorithm, depth first search, best first search, A *, etc. The A * algorithm (Astar) is one of the algorithms included in the search method category who has information (informed search method). Informed search method is known to be more efficient compared to uninformed search method [2]. For this reason, we will compare the best-first search greedy algorithm with A *, which is an informed search method. This algorithm is very good as a solution to the pathfinding process (path finder), looking for the distance of the fastest route to be taken by a starting point (starting point) to the object.

Research conducted by Ardian Fajar Rahmanto and Wijanarto from Dian Nuswantoro University entitled "Inventor of the Oprimal Pathway for New Road Routes with A * in Semarang" [3]. In that research it resulted that the application of Bidirection A * technique could find the optimal path and proved valid by proving it as much as 4 times, resulting in 3 times the optimal travel time with a heuristic value that was determined statically. Another study conducted by Xiang Liu and DaoXiong Gong from the Beijing University of Technology's School of Electronic Information and Control Engineering entitled "A Comparative Study of A-Star Algorithm for Search and Rescue in Perfect Maze" [4]. The study states that validating the use of the A * heuroustic function is superior to that of Dept-First Search in maze games. Based on research conducted by several researchers stated that the A * method is more optimal than the dept-first search method. Based on this research, the authors decided to conduct a study to compare the A * algorithm with the best-first search method to find the most optimal route in the lesprivate.id application. The purpose and benefits of this research are to find out the A * algorithm method and the best-first search greedy algorithm in determining the shortest path, making a comparison of the A * algorithm and the best-first search greedy algorithm in determining the shortest path, proving the existing theories about the best greedy algorithm -first search and A * in determining the shortest path.

2. RESEARCH METHOD

2.1. Flowchart

The method I use in this study is a comparison of the search methods using the Best-First Search (BFS) and the search method with A * using the thinking design shown in Figure 1 below,

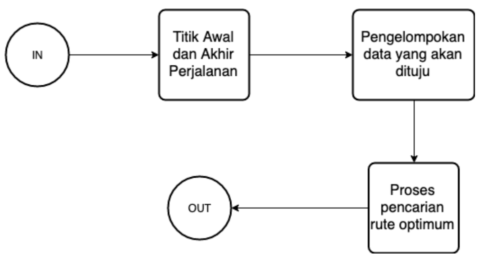


Figure 1 Research Method

Based on Figure 1 above the research method that the authors propose can be described as follows:

a. The application user enters a starting point / pickup point for reference in distance search.

b. Make a grouping or collection of possible travel routes that will be taken during the search process
c. Apply and compare BFS and A * algorithms to find the optimal route.
d. The results of the search process or the solution obtained from the algorithm that has been done.

2.2. System Architecture

After choosing the method to be carried out in this study, the authors then have the architecture of this research. The architecture is presented in Figure 2 as follows:

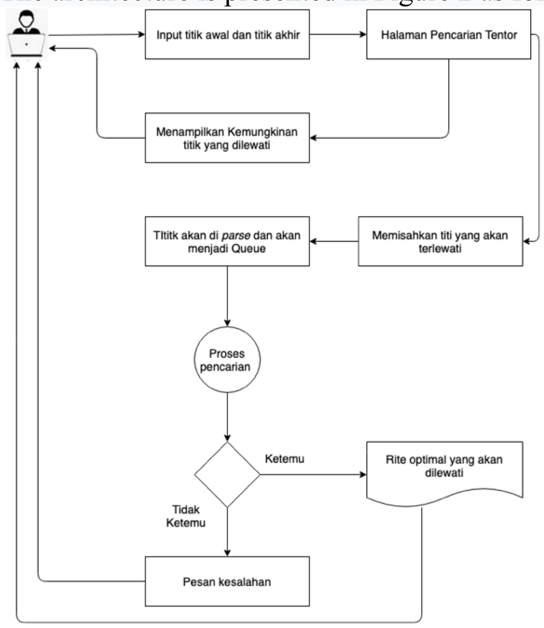


Figure 2 architecture

Explanation of Figure 2 is as follows the user enters the tentor he wants to produce a destination point or point from the tentor, then the system will separate the points of the route that have been entered by the user to be parsed and entered into the queue. From the data the system will search using BFS or A * and the system will automatically output the optimal route to be passed.

2.3. System planning

Software design that is done by the writer is by designing the ocject oriented approach which is realized by UML (Unified Modeling Language), here is the design done by the author:

a. Usecase Diagram

Users or actors involved in the application are the user / customer, tentor and admin, as shown in Figure 3 below:

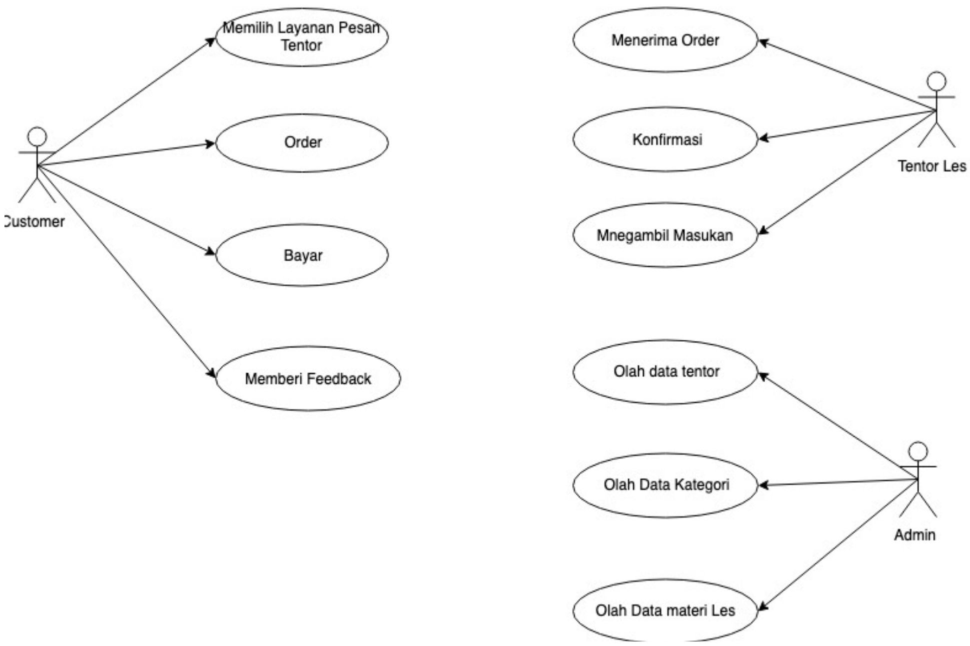


Figure 3 Use Case

Based on picture 3 there are 3 actors or 3 users found in the lesprivate.id application with the functions of each different actor as in the following table:

Table 1 Actor Function

NO	Aktor	Function
1	Customer	Choosing Services Message tentor, order, pay, provide feedback
2	admin	Process tenor data, category and tutoring material data
3	Tentor Les	Receive orders, confirm and take feedback

b. *Activity Diagram*

In picture 4 there is a picture that can illustrate the activities or activities carried out by users in the application lesprivate.id. that is the process from choosing tentor to finding the optimal route using the methodA*.

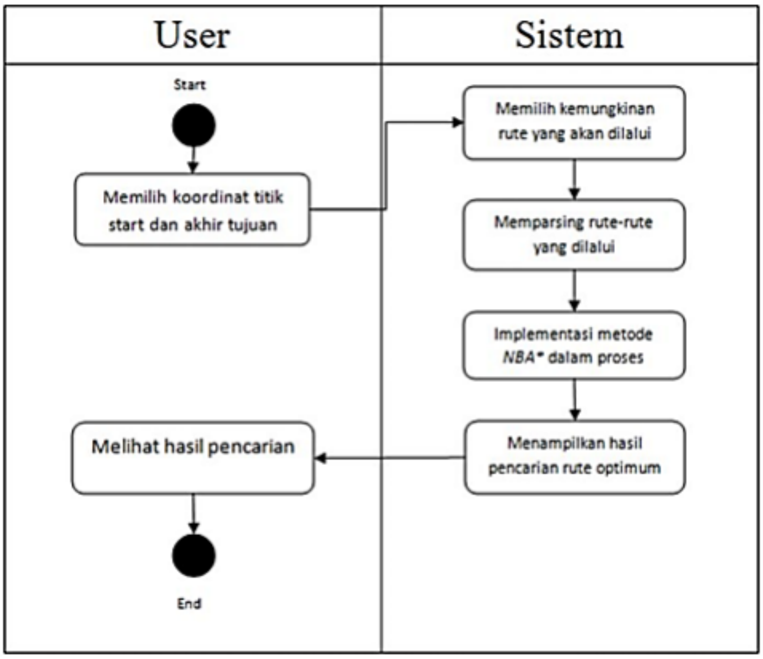


Figure 4 Activity Diagram

c. *Sequence Diagram*

The sequence diagram shown in Figure 5 below illustrates the steps in ordering tentor from determining the pick-up point to finding the best alternative with the method A*.

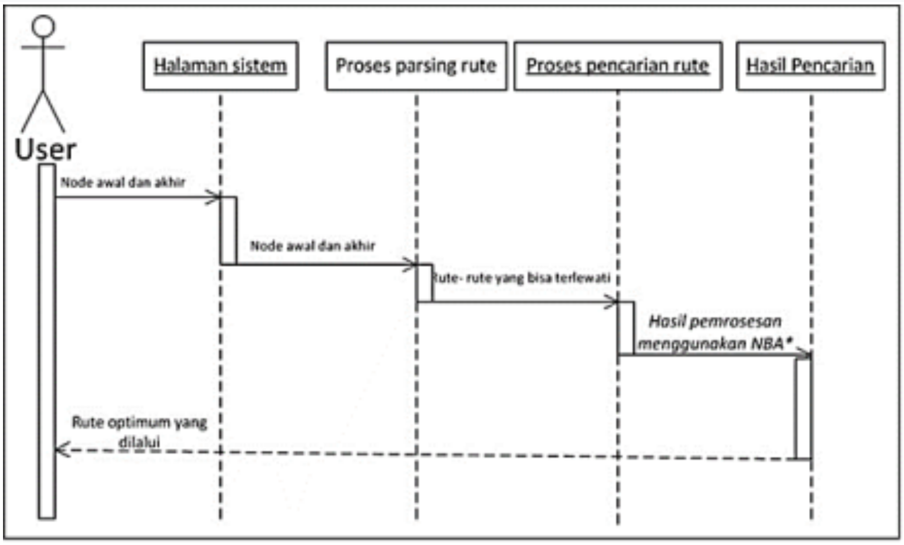


Figure 5 Sequence Diagram

d. *Class Diagram*

Figure 6 is a picture of a class diagram that illustrates the relationships or relations of several interconnected classes.

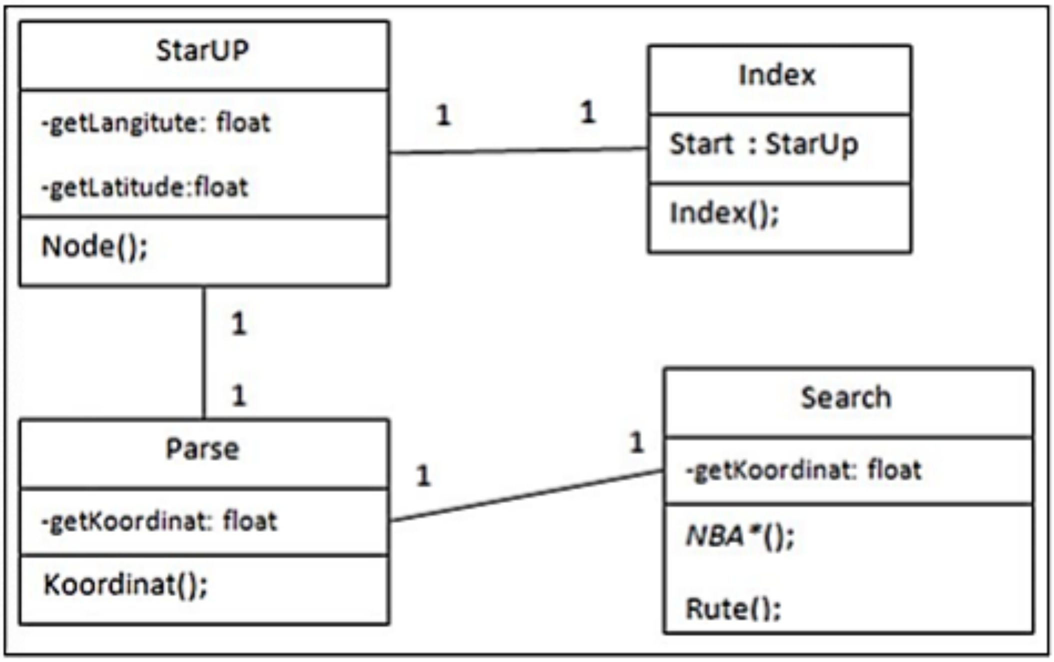


Figure 6 Class Diagram

2.4. Database Design

The following is a table design of the lesprivate.id application which was built using the mysql database. Database design drawings are shown in Figure 4.

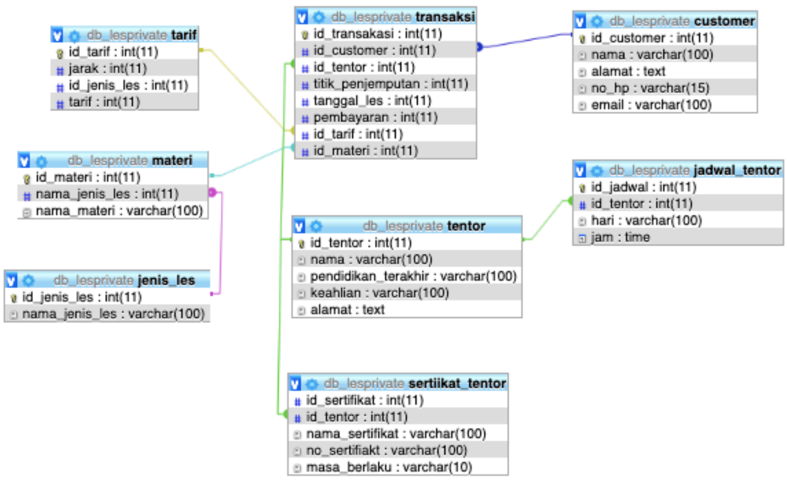


Figure 7 Database Design

3. RESULTS AND DISCUSSION

*3.1.Comparison of Algorithms BFS and A**

The following is a discussion about discussing the Best-First Search method and A *. when following the authors do the manual calculations in case studies that have been designed by the author.

3.1.1.Algorithms BFS

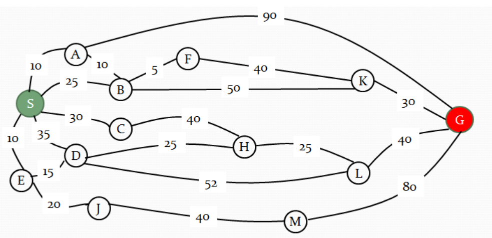
Breadth-First Search (BFS) algorithm, also known as widening search algorithm, is a common technique used to traverse graphs. In summary [9], this algorithm has the following procedure:

1. Traversal starts from node v;
2. Visit all vertices v;
3. Visit all neighboring vertices v first;
4. Visit the nodes that have not yet been visited and neighbor with the nodes that were previously visited, and so on. [7]

Best First Search is a type of algorithm that only calculates estimated costs, can be formulated:

$$f(n) = h'(n). [5] \qquad (1)$$

Here is an example of a case with the investigation using Best First Search :

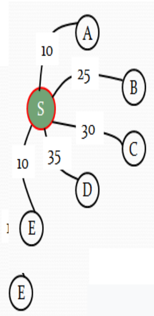


n	S	A	B	C	D	E	F	G	H	J	K	L	M
h'(n)	80	80	60	70	85	74	70	0	40	100	30	20	70

Figure 1 study case

Sample case :
Explanation of Figure 8 is in this study, to make a comparison of BFS and A * the authors make a scenario that is by calculating the most optimal search from point S to point G. The following are the steps of completion using the BFS method:

Step 1 :

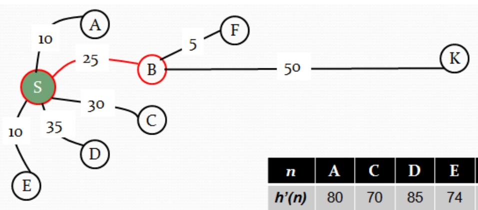


n	S	A	B	C	D	E
h'(n)	80	80	60	70	85	74

Figure 9 BFS Step 1

Figure 9 is illustrating some choices that can be taken to achieve optimal goals, of the 5 path choices that can be taken optimally is path B because it has the closest distance, then path B is the most suitable path to choose

Step 2:



n	A	C	D	E	F	K
h'(n)	80	70	85	74	70	30

Figure 10 BFS Step 2

Figure 10 is the completion of BFS in the following steps there are 2 proposed paths to be taken to achieve optimal rite search. In this step the path K is chosen because it has a shorter distance than F

.

Step 3:

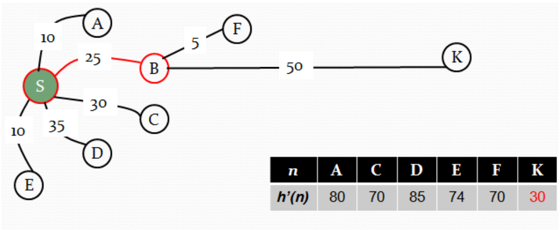
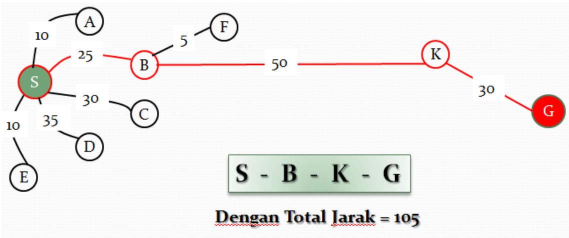


Figure 11, there are some proposed paths, but the most optimal path is the G line with a distance of 0.

Figure 2 BFS Langlah 3



Solusion:
Based on calculations with BFS done in steps 1 to 3 there is the best solution, namely by traveling a distance of 105 as shown in Figure 9.

Figure 3. Solusion BFS

3.1.2. Algoritma A (A Star)*

A* algorithm is an improvement of the BFS method by modifying the heuristic function. A * (A Star) will minimize the total cost of the track. In the right conditions, A * will provide the best solution in optimal time. [3]

In a simple case search route, where there are no obstacles on the map, A * works as fast and as efficiently as BFS. In the case of maps with obstacles, A * can find a solution to the route without being "trapped" by the obstacles

Searching using the A * algorithm has the same principles as the BFS algorithm, only with two additional factors.

1. Each side has a different "cost", how much does it cost to go from one node to another.
2. The cost of each node to the destination node can be estimated. It helps

search, so it's less likely we search in the wrong direction. The cost for each node does not have to be a distance [6]. Cost can be time if we want to find the way with the fastest time to pass. For example, if we drive a normal road it could be the closest distance, but passing the toll road usually takes less time.

The cost between nodes is the distance, and the estimated cost from a node to the destination node is the sum of the distances from that node to the destination node. Or for more convenience it can be shown as follows. [8]

$f(n) = g(n) + h(n)$
with:
$f(n)$ = evaluation function
$g(n)$ = costs (costs) that have been incurred from state to staten
$h(n)$ = estimated cost to arrive at a destination starting from n

Note that this algorithm only works if the estimated cost is not greater than the actual cost. If the estimated cost is greater, the path found may not be the shortest one. [4]

The node with the lowest value is the best solution to be checked first in g (n) + h (n). With a heuristic function that meets these conditions, then searching with the A * algorithm can be optimized.

The optimization of A * is straightforward enough to be analyzed when used with search trees. In this case, A * is considered optimal if h (n) is an admissible heuristic, that is, the value of h (n) will not provide a more cost-effective evaluation of the objectives. One example of admissible heuristic is the distance by drawing a straight line because the closest distance from two points is by drawing a straight line.

Algorithm A * calculates heuristic functions by adding actual costs to estimated costs. So we get the formula:

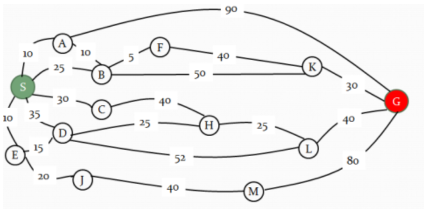
$$\boxed{f(n) = g(n) + h'(n)}$$

Fugure 4 Algoritma A*

g(n) = Actual Cost from Initial Node to Node n

h'(n) = Estimated cost from Node to Destination Node

Study Case :

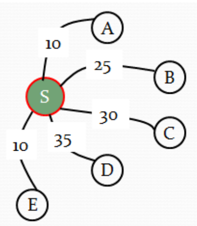


n	S	A	B	C	D	E	F	G	H	J	K	L	M
h'(n)	80	80	60	70	85	74	70	0	40	100	30	20	70

In figure 14 there are case examples using the A * method. The following are some steps to complete the method A* :

Figure 14 Examples of CasesA*

Step 1 :

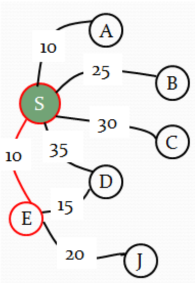


n	S	A	B	C	D	E
h'(n)	80	80	60	70	85	74
g(n)	0	10	25	30	35	10
f(n)	80	90	85	100	120	84

Figure 15 is the first step in completion using the A * method, in that step there are 5 steps and step E is the best route with a distance of 84.

Figure 5 A* Step 1

Step 2 :

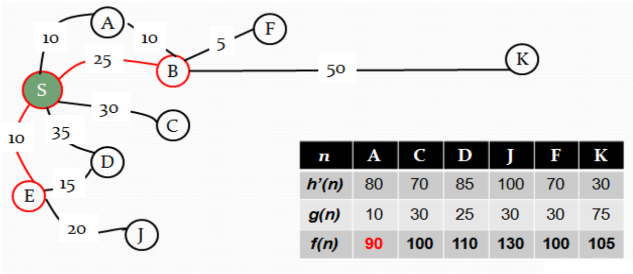


n	A	B	C	D	J
h'(n)	80	60	70	85	100
g(n)	10	25	30	25	30
f(n)	90	85	100	110	130

Figure 16 is the second step of completion using the A * method. in this step there are several choices and the most optimal route is the route to point J.

Figure 6 A* Step 2

Step 3:

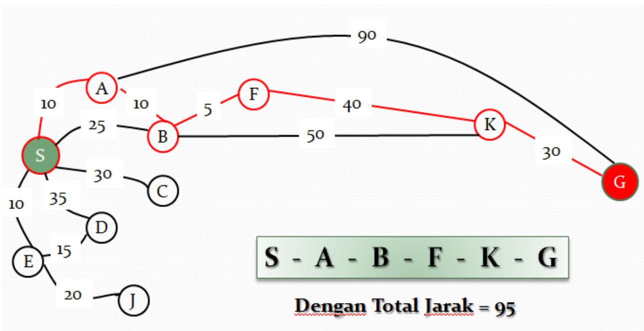


n	A	C	D	J	F	K
h'(n)	80	70	85	100	70	30
g(n)	10	30	25	30	30	75
f(n)	90	100	110	130	100	105

Figure 17 is the third step of completion with A *. in this step the route to point K is the best route.

Figure 7 A* Step 3

Solusion:



In Figure 18 there is the best solution using the A * method, which is a distance of 95.

Figure 8 Solusion with Method A*

3.2. Comparison Chart

Based on research with case studies that the authors describe, the resulting comparison comparison graphs with the best First Search and A * are shown in the following graph:

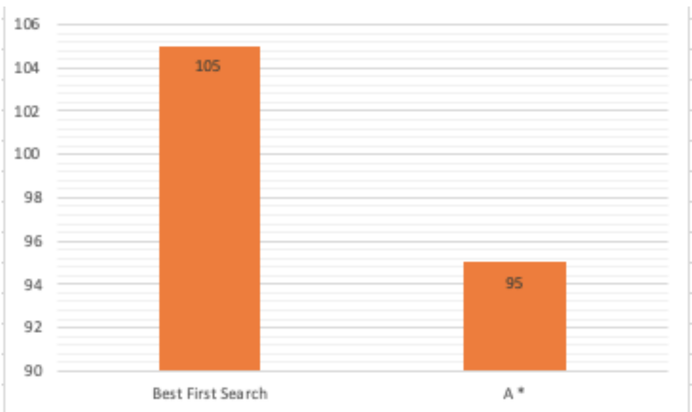


Figure 19 Graph of Comparison Results of BFS and A *

3.3. Testing

Based on the results of calculations that the authors do, the results obtained are calculations using A * more optimal than calculations using BFS, here are the application tests that the authors built using a * algorithm:

3.3.1. User Login page

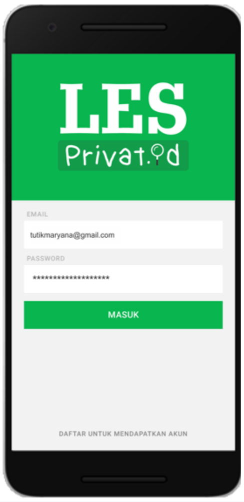
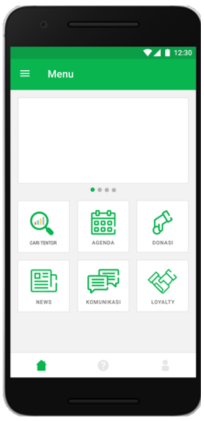


Figure 20 shows the user interface for logging in or entering the lesprivate.id application. To be able to enter the application the user must first log in by entering the username and password as in the example in Figure 17.

Figure 20 User Login Display

3.3.2. Main page



On picture 21 is the main menu image of the lesprivate.id application. On the main page there are several menus, namely: search menu tentor, news, donations, messages and loyalty.

Figure 21 Figure Main Page

3.3.3. Case 1 Looking for motorcycle tentors
Here are the results of the search for motorcycle tentor in the applicationprivate.id

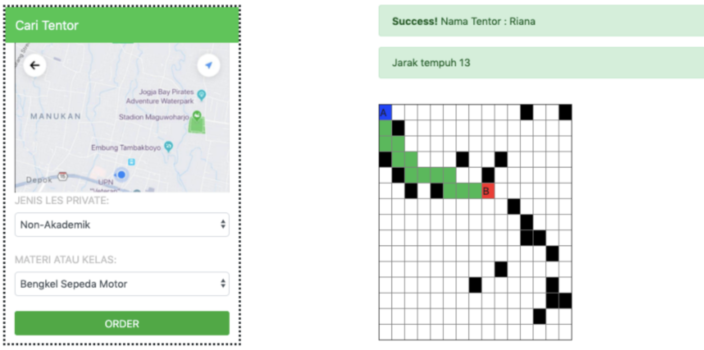


Figure 22 Motorcycle Mentor Search Results

3.3.4. Case 2 Looking for a Cooking Tent

Here are the results of the search for cooking in the lesprivate.id application

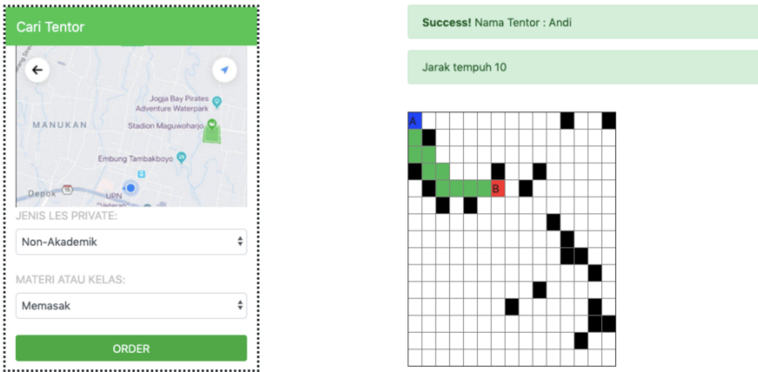


Figure 23 Search results for cooking tentor

3.4. Table of test results

Here is a table of the results of the suitability of the application with the calculations that the author did:

Table 2 Table of Testing Results for lesprivate.id Application

NAMA LES	SOLUSI 1	SOLUSI 2	SOLUSI 3	SOLUSI TERBAIK	HASIL SISTEM
BENGKEL SEPEDA MOTOR	14	16	13	13	13
MEMASAK	11	10	11	10	10

4. CONCLUSION

The results of research for the search for the shortest route in determining the route tentor les private on les private.id application in the district. Sleman is able to show the route to the closest tentor location to go to and the optimal route.

The shortest route search for tentotr using the A * algorithm always manages to find a road solution if indeed there is a path from the starting point to the destination. Research using A * can determine the best route (path) from the starting point (start) to the end point (finish) with obstacles obstacles are given in each route. From the test results, the route found is the best route with the smallest value f (n) compared to other routes (lines).

5. SUGGESTIONS

In future studies, it is necessary to modify the A-star method by combining with other methods, for example the DIJKSTRA method so that the resulting route can be optimized in terms of distance and search time.

REFERENCES

[1] Hardianto. (2013). Implementasi Algoritma Heuristik untuk optimisasi rute terpendek. Jurnal Teknologi Informasi dan Komunikasi. 4(2): 79-88.

[2] Russel, S., & Norvig, P. (2010). Artificial Intelligence: A Modern Approach. New Jersey: Prentice Hall.

[3] Ardian F. R., Wijanarto (2017). Penemu Jalur Optimal Untuk Rute Jalan DenganNew Bidirectional A* Di Semarang. Techno.COM, Vol. 16, No. 2,

[3] Kusumadewi, Sri. (2003), Artificial Intelegence (Teknik dan Aplikasinya). Yogyakarta, Graha Ilmu.

[4] Xiang Liu & DaoXiong Gong (2011). A Comparative study of A-star algoritm for search and rescue in perfect maze. Technology 1978-1-4244-8039-5/11/2011 IEEE.

[5] Suyanto. (2007), Artificial Intelligence Searching, Reasoning, Planning dan Learning, Bandung, Informatika.

[6] Talai,Moh Bandrigo, Muh. Yamin, dan Bambang Pramono. 2015. “Aplikasi Pencarian jalur terpendek pada Rumah Sakit umum Bahteramas menggunkan algoritma A*” JURNAL INFORMATIKA (FTEKNIK UHO).

[7] Riftadi M(2007), Variasi Penggunaan Fungsi Heuristik dalam Pengaplikasian algoritma A*, Teknik Informatika ITB.

[8] Roger S. Pressman, Software Engineering ,7th Edition., 2010.

[9] Yongke Yoswara, "Penerapan Algoritma Simplified-Memory-Bounded A* Dan Algoritma Greedy-Best First Search Dalam Pencarian Lintasan Terpendek Dan Efisiensi Tarif perjalanan Antar Kota ," 2011.