Application of ant colony optimization algorithm to determine optimal value in choosing tourist attractions in Bangkalan – Madura

Cite as: AIP Conference Proceedings **2679**, 020009 (2023); https://doi.org/10.1063/5.0111287
Published Online: 04 January 2023

Aeri Rachmad, Muhammad Syarif and Eka Mala Sari Rochman

Application of Ant Colony Optimization Algorithm to Determine Optimal Value in Choosing Tourist Attractions in Bangkalan – Madura

Aeri Rachmad[1,a)], Muhammad Syarif[1], Eka Mala Sari Rochman[1]

[1]*Department of Informatics, Faculty of Engineering, University of Trunojoyo, Madura, Bangkalan, Indonesia*

[a)]*Corresponding author: aery_r@yahoo.com*

Abstract. The impact of COVID-19 leaves a deep sadness, especially in the tourism sector. Many tourist places are not open to prevent the transmission of this virus. Madura is one of the islands located in the province of East Java which has many tourist attractions. Bangkalan is one of the districts in Madura which has 21 tourism spots. There are many tourist attractions scattered in Bangkalan district, but there is a problem arisen in determining the shortest path to get to these tourist attractions. There are several route options available in each area. Optimal value search can be used to obtain the highest and lowest values of a problem. One of the popular problems that can be solved by optimization algorithms is the Traveling Salesman Problem (TSP) to determine the closest route using the Ant Colony Optimization algorithm. The ant algorithm is an algorithm adopted from the behaviour of the ant colony. An ant colony can find the shortest route between the nest and a food source based on footprints on the trajectory it has traversed. The more ants that pass through a track, the clearer the footprints will be. Ant Colony algorithm is very appropriate to be applied in solving optimization problems, one of which is to determine the shortest path. The final result of this discussion is the algorithm used is able to determine the shortest path to find tourist destinations as an alternative route. The accuracy results obtained are 100% with a rho value of 0.5, an alpha value of 1, and a beta value of 1.

INTRODUCTION

For Indonesia, the spread of the Corona virus has had an impact on the economy which can be seen in the trade, investment, and tourism industry sectors. Various kinds of tourism in Indonesia are closed due to Covid-19. However, after the implementation of the new normal, tourism objects are slowly reopening by implementing strict health protocols. Tourism is one of the sectors that contributes to regional income, but the revenue budget from this sector has decreased sharply since the spread of the covid-19 virus [1][2].

On the island of Madura itself has many tourist attractions, but many attractions are not known to the public and are often missed when people want to visit certain tours. Some visitors also missed those places during the trip which are not known to the public. In Bangkalan district, there are 18 sub-districts with several tours, to visit these attractions, tourists usually have limited time to choose which tourist attraction are in the sub-district to visit [3][4]. In choosing a tourist attraction, a tourist must take into account the shortest distance to be traveled in order to estimate the time required. One of them is the Traveling Salesman Problem (TSP). The distance variable between the points or objects to be visited is the weight of the graph that must be calculated. Several methods regarding finding

The First International Conference on Neuroscience and Learning Technology (ICONSATIN 2021)
AIP Conf. Proc. 2679, 020009-1–020009-7; https://doi.org/10.1063/5.0111287
Published by AIP Publishing. 978-0-7354-4300-6/$30.00

the shortest route include optimization algorithms such as the Tabu Search algorithm, genetic algorithm, Dijkstra algorithm or Ant Colony Optimization algorithm.

One of the problems that are often encountered in everyday life is the search for the optimal route. Where this is in terms of determining the shortest route, determining the optimal amount for production, determining the highest credit risk value at the bank. Conventional methods are often still used in solving shortest path problems. The use of the ant algorithm method that will be used is expected to be able to solve the problem of the optimal value of the selection of tourist objects with more varied results and with a shorter calculation time. The search for the shortest path has been done, using the Ant Colony Optimization (ACO) ant algorithm on the shortest path search [5].

The optimization method with the ant algorithm according to Research (sari) is very appropriate to be applied in solving optimization problems, one of which is to determine the shortest path. Ant Colony Optimization (ACO) is an algorithm adapted from the behavior of ant colonies. Where the behavior of the ant colony can find the shortest route on the way from the nest to the food source. This is based on the footprints on the trajectory that has been passed, because the more ants that pass through a track, the more clearly the footprints of the ants will be seen [6].

In this research, this study aims to apply the Ant Colony Optimization (ACO) algorithm to find the shortest route for all tourist attractions in Bangkalan district. It is hoped that later they can obtain information on the shortest route that must be taken by tourists to visit all tourist attractions in each sub-district.

METHODS

This research was conducted in Bangkalan district with one starting point and seventeen attractions in Bangkalan district. The distance between tours is taken based on the distance from the tourist location to the city center. Table 1 shows a tabular regarding distance data between tourist objects.

TABLE 1. Tabular of distances between tourist objects in Bangkalan Regency (km)

Attractions	Bukit Geger	Api Alam Konang	Rongkang	Maneron Beach	Pesarean Aer Mata	Kolla Lagundih	Light house	Fort Erfprins	Great Tomb of Arosbaya
Bukit Geger	0	29	21	20	16	35	40	31	17
Api Alam Konang	29	0	43	40	36	57	62	50	38
Pantai Rongkang	21	43	0	40	32	28	26	23	32
Maneron Beach	20	40	40	0	19	37	42	30	19
Pesarean Aer Mata	16	36	32	19	0	23	28	16	1
Kolla Lagundih	35	57	28	37	23	0	5	6	22
Lighthouse	40	62	26	42	28	5	0	11	27
Fort Erfprins	31	50	23	30	16	6	11	0	16
Great Tomb of Arosbaya	17	38	32	19	1	22	27	16	0

Ant Colony Optimization (ACO)

Ant Colony Optimization (ACO) or ant algorithm is used to find the optimal route to visit tourist attractions in the Regency on Madura Island. ACO is adopted from the behaviour of ants known as the ant system. Naturally, the ant colony is able to find the shortest route on the way from the nest to the food source [7][8].

Based on the footprints on the trajectory that has been passed by the ant colony, the colony can find the shortest path between the nest and the food source. The more ants that pass through a track, the more obvious the footprints will be. So that, the density of ants that pass through the path traversed by ants in small quantities is decreasing over time, and will not even be passed at all. This system is applied vice versa, the trajectory traversed by ants in large numbers will increase in density or even all ants pass through the trajectory.

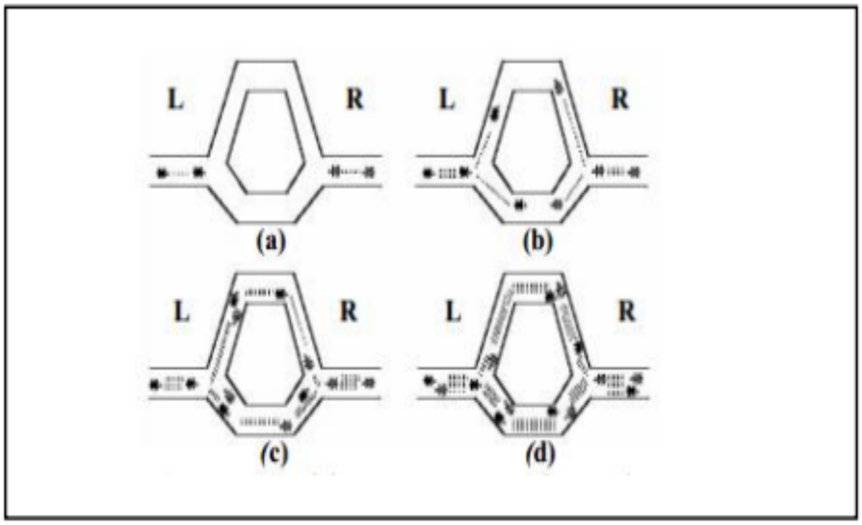

FIGURE 1 The journey of ants to find food sources.[9]

Figure 1a is the search for the shortest route from the nest to the food source, where there are two groups of ants. The L group of ants moves from left to right while the R group of ants departs from the opposite side. The starting point of departure for these two groups is the same and in the decision-making position which side of the road to take. Group L is divided into two groups again. Some ants go up and some go down. Group R also does the same with group L

Figure 1.b and Figure 1.c show the pheromones or footprints of groups of ants walking at the same speed on the path they have travelled. The pheromones is left by the ants passing the upper path that have undergone a lot of evaporation because the ants passing through the upper path are fewer than the ones below. This is because the distance travelled is longer than the lower road.

Figure 1.d shows that the other ants finally decide to go down the path because there is still a lot of pheromones left, while the pheromone on the top road have evaporated a lot so that the ants does not choose the top path. The more ants that pass through the road, the more ants that follow, the fewer ants that pass through the road, then the pheromone left behind decreases and even disappears. From here, the shortest path between the nest and the food source is chosen [10].

RESULT

To get the shortest path in this research, the ACO program was created using the Python programming language. In order to get the best results, several stages were passed [11][12], namely:

1. Identification d_{ij}

d_{ij} is the distance from node i to node j. In this study, for example, from the initial tour to the destination to be addressed.

Initialization of Initial Parameters.

The initial parameters are α, β, ρ, pheromone was represented by the symbol (τ_{ij}) at the t time, initially given the initial value of 1 which later changed with the pheromone update at the t stage. Here are the values parameter:

$\alpha =$

$\beta = 2$

$\rho = 0.5$

$\tau_{ij}(t) = 1$

2. Determine the number of ants

At this stage, it was the determination of the number of ants that was placed on each node to do the tour. The number of ants was symbolized by (m) and is given a value according to the number of tourist attraction nodes. For example, there were 17 tours, then the number of ants was 17.

3. Create a tablature

Ants that have been placed on each node started to tour and generate a path or route. The number of tabulists were proportional to the number of ants

1. Steps to determine tabulist:

a. Put the ant on node i

b. Suppose on the 1st tabulist by the 1st ant. First, the ant was placed at node 1, then node i was the same as node 1. Next, the ant will go to node j.

c. Specifies node j

$$Invers\ Jarak = \eta = 1/dij \quad (1)$$

$$Propabilitas = p_{ij} = \sum[\tau_{ij}(t)]^{\alpha}[\eta_{ij}]^{\beta} \quad (2)$$

d. Node j was a node between nodes 1 to 17 on the tourist attraction node. The way to determine it was based on the greatest probability value, to find out the formula was used:

e. Looking for the next node

After getting node j, for example 3, then look for the next node by changing node j to node i. Then after node 3 became node i, then again determining node j with the same formula but on the condition that the next node j was not a node that has been passed (eg node 1 or 3). Search for nodes.

The next step was done in the same way until all nodes were passed. The nodes that have been passed were then stored in the tabulist as a path

2. Calculate Probability

At this stage, it was the search for the largest probability acquisition, and the smallest pheromone on the path was carried out to be the best route. Here are the steps:

a. Determine path probability

Calculating the probability of a tabular with the formula:

$$L_k = \sum P_{ij}^{k}(t), \sum P_{ij}^{k}(t) \quad (3)$$

sum of all probabilities in the tabular. For example, in the 1st tabulist with path 1 – 5 – 9 – 16 – 8 – 17 – 10 – 6 – 12 – 13 – 14 – 15 – 7 – 3 – 11 – 4 - 2, then it was added up the probability values from 1 to 5, 5 to 9, 9 to 16 and so on. Based on the calculation, tabulist 1 obtained a probability value of L_1= 5.099. Next, it calculated the next tabulist in the same way.

a. Calculating pheromone gain on path

Calculate temporary pheromone with formula:

$$\Delta \tau_{ij}^{k} = \frac{Q}{L_k} \quad (4)$$

b. Counting global pheromones
Global pheromones are calculated using the formula, namely

$$\Delta\tau_{ij} = \sum_{k=1}^{m} \Delta\tau_{ij}^{k} \quad (5)$$

summing pheromones while on all tabulists. Then a global pheromone was generated

c. Calculating the pheromone gain on each tabulist
This step was carried out using the equation

$$\Delta\tau_{ij} = \Delta\tau_{ij} + \Delta\tau_{ij} \quad (6)$$

add temporary pheromone to each tabulist with global pheromone.

The value of m (number of ants) was used when searching the path of ant visits. Testing the value of m was carried out to analyze how the influence of the value of k on the distance results obtained by the ACO method. The value of m must be greater than 0, therefore the value of k used in the test was 1-100 with multiples of 10. Assuming all tourist attractions were passed, the test results for the value of *k* could be seen in Table 2 and Figure 2.

TABLE 2. Accuracy and optimal distance of changes in the number of ants

Number of ants (*m*)	Accuracy	Distance (km)
1	56,25%	343
10	75%	175
20	81,50%	173
30	82,50%	162
40	85%	159
50	87,50%	155
60	89%	154
70	91,50%	152
80	93%	150
90	93%	150
100	93%	150

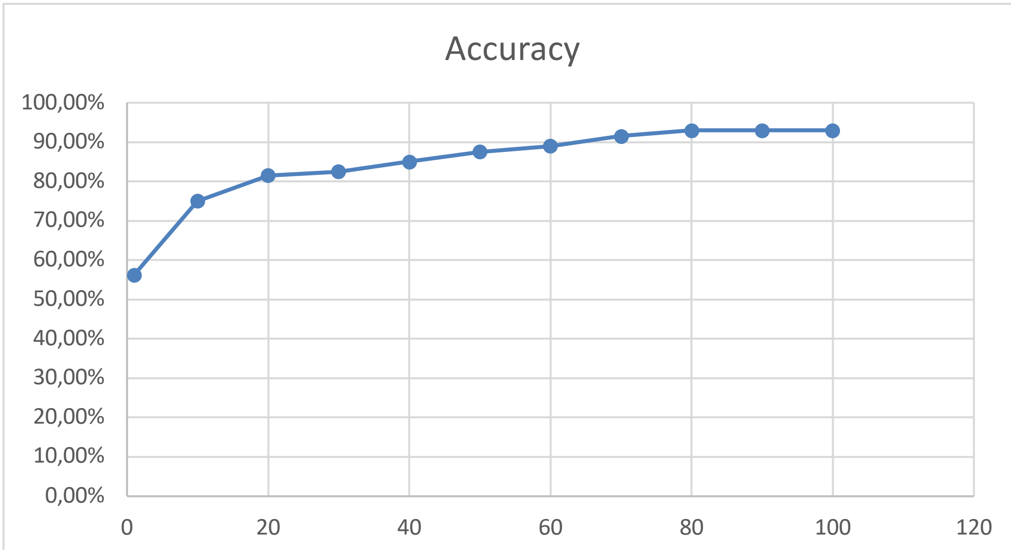

FIGURE 2 Accuracy on the change in the number of ants

Table 2 shows the change in ants and the distance calculated by the system with a value of $\alpha= 1$, $\beta = 1$ and $\varrho = 0.5$ and the value of *m* starts from 1. After getting the results of several m parameters tested, the m value of 80 have reached the optimal distance of 150 km and an accuracy of 93%. Then the value of the parameter *m* of 80 could be concluded that the most optimal ant was 80 because the accuracy and distance values did not change even though the number of ants was added. Figure 2 states that the x-axis is the number of ants and the *y*-axis shows the percentage of data accuracy. The picture shows the change in the accuracy of the test results using changes in the number of ants. The more the number of ants, the more accurate the results will be.

CONCLUSIONS

ACO can be used for shortest distance searches. In this study, ACO is used to find the shortest route for all tourist attractions in Bangkalan district. The test results show that

1. The more ants and the number of iterations the truth will be more accurate
2. Determination of the optimal value can be done by determining the greatest probability value and the smallest pheromone value.
3. In the experiments, getting a minimum error value the number of ants does not have to match the number of tourist objects. Then if the greater the number of ants and iterations, the resulting error value will be smaller, in other words the resulting accuracy will be better.
4. While the most optimal alpha value in this study is 1 and the most optimal beta value is 1, then the most optimal rho value in this study is 0.5.

The obstacles in determining the shortest path of all tourist attractions in Bangkalan district should also be considered. In the future, the program can add a map visualization of tourist locations to make it easier for tourists who want to visit or plan to travel and look more visually attractive.

ACKNOWLEDGMENT

We would like to thank Trunojoyo Madura University, which has provided the opportunity for researchers to be able to conduct independent research with the Research Group Research scheme in 2021. We also thank the Tourism and Sports Office of Bangkalan Regency for providing researchers with insight into tourism in Indonesia. Bangkalan Regency.

REFERENCES

1. A.A. A Ribeka Martha Purwahita, Putu Bagus Wisnu Wardhana, I Ketut Ardiasa, I Made Winia, *Jurnal Kajian dan Terapan Pariwisata*. Vol. 1, No.2, (2021).
2. P. L. Pearce, *The Journal of Tourism Studies*, Vol.2, No.1, May 1991. Pp. 46-55, (1991)
3. E. M. S. Rochman, A. Rachmad, *Advances in Social Science, Education and Humanities Research* **410**, (2020).
4. E. M. S. Rochman, I. Pratama I, Husni, A. Rachmad, *Journal of Physics: Conference Series* 1477 022033, (2020).
5. I. Mutakhiroh, Indrato., T. Hidayat, Yogyakarta, *SNATI* 2007, (2007).
6. D. N. Sari, and S. Maharani, Scan Vol. IX Nomor 1 Februari 2014. (2014).
7. D. R. Anamisa, E. M. S. Rochman, A. Rachmad, *Journal of Multidisciplinary Engineering Science and Technology (JMEST)* **6**(1), (2019).
8. D. R. Anamisa, E. M. S. Rochman, A. Rachmad, *International Journal of Engineering Research and Application* **7**(9), (2017).
9. A. Leksono, Thesis, *Skripsi Program Studi Matematika Jurusan Matematika Fakultas Matematika Dan Ilmu Pengetahuan Alam Universitas Diponegoro Semarang*. (2009).
10. J. Kponyo, dkk., *16th International Conference on Computer Modelling and Simulation*, 141-146, (2014).
11. Lin Yuan,Chang-An Yuan,De-Shuang Huang. Journal of Complexity **2017,** (2017).
12. D. R. Anamisa, A. Rachmad, & E. M. S. Rochman, *In Journal of Physics: Conference Series* (Vol. 1477, No. 5, p. 052053). IOP Publishing (2020).