

Ant Colony System Based Ant Adaptive For Search of the Fastest Route of Tourism Object Jember, East Java

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Abstract. The fastest route search is a problem to find routes having a relatively small or empty number of congestion or density so that the required travel time is faster to get to a location. One of them is the route to the tourist attraction in Jember regency, East Java has many relatively solid lines. Some researchers have done a lot of research on finding the shortest path using Ant Colony System (ACS) method. However, the ACS method has a weakness, where more ants pass through a path, the clearer the footprint but the volume of ants passing through the path is also longer. Therefore in this research use ant adaptive on ACS method to find the fastest path to the tourist location in Jember Regency. Due to the increasing number of densities, it takes longer to get to the food source. In this study, ant adaptive for ACS method is used to determine the optimal number of ants in searching for the fastest path to the tourist attraction in Jember District, East Java. Various trials are done to prevent the search process of resolving the already traced solution space to find the fastest path. The fastest path does not have to have the shortest path but has the fastest time with the paths having relatively little or no density at all. The results showed that ant adaptive for ACS method developed in this research is able to find the optimal number of ants in determining the fastest paths to the tourist object so that the search result of the fastest route of tourist attraction in Jember Regency in accordance with the reality of the passable path and has a density relatively small or almost nonexistent. The success rate was conducted on 8 tourist objects in Jember with 98 paths tested using road data in Jember regency, East Java with the fastest path solution influenced by the closer to the optimum distance, the more number of ants influenced.

1. Introduction

The volume of the traffic density, known as jamming, is a condition of a road which has excessive volume of vehicles. This condition makes several travel routes not ideal and ineffective. Generally, shorter routes take shorter short travel time. In fact, it does not always happen like expected. Road with heavy traffic often takes longer time to move from one place to another. That is why many travelers take alternative route to avoid heavy traffic.

This condition also happens in Jember city which is located in East Java. This city has many potential, like natural and cultural attraction. These attraction especially the natural one attracts many people to visit Jember to enjoy its nature. Based on the data, places that are most visited are papuma and watu ulo, puger sea, patemon natural bathing, waterfall tancak, Rembangan baths, Agung Bath Baths, Bedadung Hill and Water Waterfall Slopes Raung.

For traveler, saving time and cost during the journey are very important. Because of it, they always try to find the fastest route among some possible routes to reach the destination[1]. There are many heuristic methods utilized to determine the fastest route have been developed. One of the methods which can be used to find alternative way is the Ant Colony System (ACS) method [2][3][4]. ACS is a methods



than can help solve classic problems like traveling salesman problem or the shortest path problem. ACS is unique for it is inspired by the behavior of ants in the real world during the process of feeding from the nest, known as the ant systems[5][6][7]. Naturally the ant colony is able to find the shortest route in its journey from the nest to the source of food and back again, when the ants are walking, the ant leaves an information called pheromone, in its place and marks the path [8][9]. During each walk the ants release pheromones, where other ants are sensitive to the pheromone to give hope to follow in his footsteps. More or less the intensity depends on the concentration of pheromones. After some time, the shortest path will be more frequently followed and the pheromone becomes saturated with ants. So the way the ACS method works is at first, all around randomly, when ants find a different path e.g. at the intersection, they will start to determine the direction of the road randomly and when finding food, the ant will return to the colony while marking with traces of pheromones assuming the speed of all the ants is the same [10][11][12]. The pheromones left by the ants on the shorter path of the aroma will be stronger than the pheromones on longer paths and other ants will be more interested in following the path that has stronger pheromones, can be seen in Figure 1.

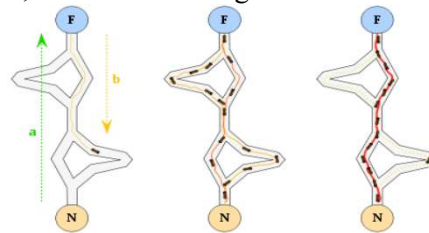


Figure 1. Trip of Colony Ants to Food Source [13]

The path which is passed more frequently will increase in density; while the one that is passed less frequently decreases in density [14][15]. Some research applying ACS have been conducted. However, the results were not satisfying since ACS has a weakness. The weakness is that to make the path be more obvious, it needs more ants to pass the path, which means the longer the volume of the ants [16][17][18]. Because of that reason, this research uses ant adaptive on ACS method to find the fastest path to the tourist location in Jember Regency. The aim of the research is to determine the optimal number of ants in searching for the fastest path to the tourism objects.

2. Research Methods

The data used in this research is 8 data of tourism objects, i.e. papuma beach and watu ulo, puger sea, patemon natural bathing, tancak waterfall, Rembangan bath, Agung Garden Bath, Bedadung Hill and Waterfall of Raung), and 98 data of path names to the object with an average distance of 3.5 km between alternative paths to tourism sites in Jember regency together with real conditions and road density data, shown in Figure 2. The values used for road density (L) data, such as loose, normal and solid, and the path length (P), can be seen in Figure 3, and the process for calculating the density data, uses Eq. (1), (2) dan (3).

$$\mu_l = \begin{cases} 1; L \leq 1b/6 \\ \frac{\frac{1b-L}{6}}{\frac{3b-1b/6}{6}}; 1b/6 \leq L \leq 3b/6 \\ 0; L \geq 3b/6 \end{cases} \quad (1)$$

$$\mu_n = \begin{cases} 0; L \leq \frac{1b}{6} \text{ atau } L \leq \frac{5b}{6} \\ \frac{\frac{P-1b}{6}}{\frac{3b-1b}{6}}; \frac{1b}{6} \leq L \leq \frac{3b}{6} \\ \frac{\frac{5b-P}{6}}{\frac{5b-3b}{6}}; \frac{3b}{6} \leq L \leq \frac{5b}{6} \end{cases} \quad (2)$$

$$\mu_p = \begin{cases} 0; L \leq 3b/6 \\ \frac{p - \frac{1b}{6}}{\frac{5b}{6} - \frac{3b}{6}}; 3b/6 \leq L \leq 5b/6 \\ 1; L \geq 5b/6 \end{cases} \quad (3)$$



Figure 2. Route Map of Jember's Tourism Location

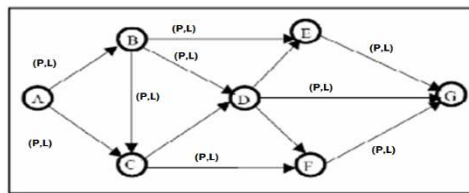


Figure 3. Density Data Representation

Traveling Salesman Problem (TSP) involves a traveling salesman who must make visits to a number of cities in peddling his products. The series of cities visited must form a path so that they can only be passed once and then back to the original city. The solution to the TSP problem in this research is to obtain the fastest path. Some researchers have done much research on TSP using heuristic methods. One of them uses the Ant Colony System (ACS) method[18][19].

The steps to apply ant adaptive method on Ant Colony System are [20]: (1) Initialization of ACS parameters, such as α , β , ρ , Q , NC_{max} , (2) Filling the first city into a taboo list, (3) Arranging the path of each ant visit to every city. An ant placed in city r chooses to go to city s by applying the rule shown by Eq. (4). If s represents the index of the order of visits, the home city is declared as $tabu_k(s)$ and other cities are declared as $\{N - tabu_k\}$, then to determine the destination city the city probability equation to be visited is used, defined in Eq (5). The calculations are performed on the basis of each $tabu_k$ with equation (6). The existence of evaporation and the difference in the number of ants passing cause the possibility of a change in the price of the ant footprint intensity between cities with Eq. (7) and Eq. (8). For the next cycle, the ant that will pass through the trajectory of its intensity price has changed. The intensity of the ant footprints between cities for the next cycle is calculated by Eq. (9).

$$v = \arg.\max \{ [\tau(r,u)] \cdot [\eta(r,u)]^\beta \} \quad (4)$$

$$p_{ij}^k = \frac{[\tau_{ij}]^\alpha \cdot [\eta_{ij}]^\beta}{\sum_{ik} \tau_{ik} \cdot \eta_{ik}^\beta} \text{ untuk } j \in \{N - tabu_k\} \quad (5)$$

$$k \in \{N - tabu_k\}$$

$$p_{ij}^k = 0 \text{ untuk } j \text{ lainnya}$$

$$L_k = d_{tabu_k, (n), tabu_{k(1)}} + \sum_{s=1}^{n-1} d_{tabu_k, (n), tabu_{k(s+1)}} \quad (6)$$

$$d_{ij} = \sqrt{(x_i - x_j)^2 + (y_i - y_j)^2} \quad (7)$$

$$\Delta\tau_{ij} = \sum_{k=1}^m \Delta\tau_{ij}^k \quad (8)$$

$$\Delta\tau_{ij}^k = \frac{Q}{L_k} \quad (9)$$

3. Results And Discussion

The process for calculating the normalization of the road density values uses Eq. (1). The result of normalization of the density value of the road is that the greater density value indicates the longer journey of the path to the tourist location, and vice versa. Based on data 98 data path name to the object with an average distance of 3.5 km, a value of 0.1 to 1 is obtained, shown in Table 1. As the smaller columns will progressively take the path. After getting the value of Road density, it is calculated by ACS method. ACS method with ant adaptive to find the fastest path requires the initial parameters presented in Table 2.

Table 1. List of Normalization of Road Density Values

Volume		Density		
Long Street	Short	μ_l	μ_n	μ_d
	Moderate	0.1	0.25	0.5
	Long	0.25	0.5	0.75
		0.5	0.75	1

Table 2. ACS Parameter Data with Ant Adaptive

Parameter	Value	Information
α	0.2	Parameter weight for pheromone of each path
β	2	Weight parameters for the visibility of each track
ρ	0.2	The pheromone evaporation parameter
Q	0.1	Constant quantity of trace placed by ants
NCmax	20	Maximum number of iterations

Then calculating the distance between nodes and calculating the visibility between nodes and place each ant at each node is carried out randomly. The initial position of the ants on this first node is the first position of the taboo list of each ant. The next step is visiting other nodes that do not exist on the taboo list based on the rules of the random proportional rule. The node with the greatest probability is the node to be visited. After the visit filling in the visit on the taboo list is done. After all ants visit all cities and the tabu lists of each ant is full, the length of each ant track in visiting all the cities is calculated based on the taboo of each ant list, as shown in Table 3. The last step is performing the process of renewal of pheromones on each segment and emptying the tabs of each ant's list. This process is repeated and will stop if NCmax has been met.

For example, the initial city is allocated to the Puger region, which is at node 17 and goes to the Petemon Bathing Town at node 7. The process of storing the node with the change of ACS method

parameters and the influence of the number of ants can be seen in Figure 4. The optimal trajectory result is obtained at the node 17,19,14,13,6,7 ie by route from Puger - Kasiyan - Gumukmas - Semboro - embankment - Patemon Baths with distance 25 km with ant adaptive of 20, can be seen in Figure 5.

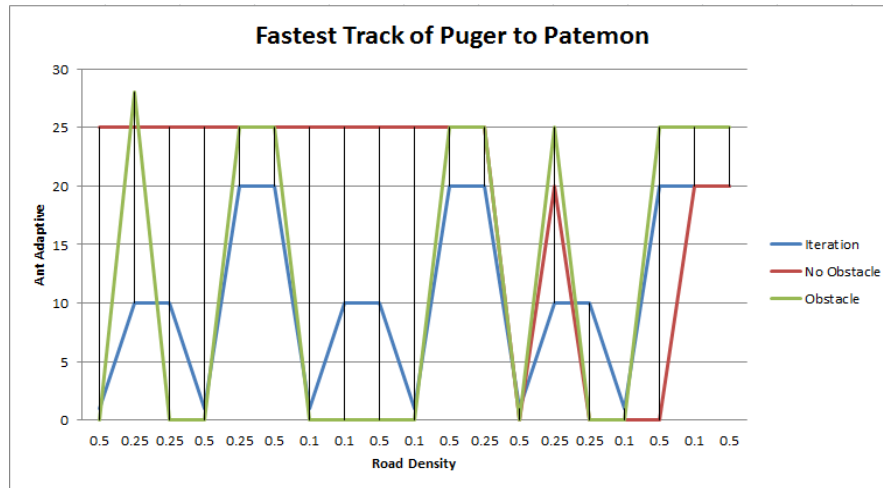


Figure 4. Result of Fastest Track Puger to Patemon

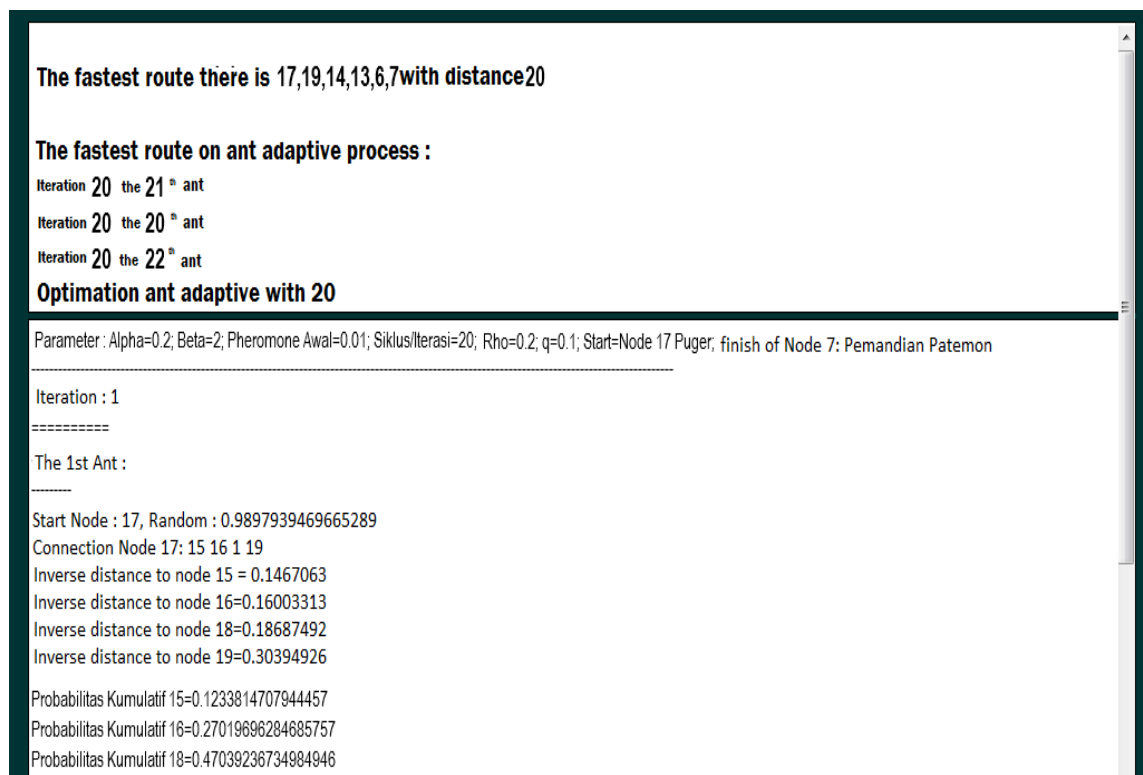


Figure 5. Implementation of Ant Colony System Based Ant Adaptive For Search of The Fastest Route of Tourism Object Jember

4. Conclusion

Jember regency is one of the regencies that has many tourism objects. To get to the location of the tourism objects, the path taken often occurs congestion. Because of the ineffective paths, many travelers try to find alternative routes that have relatively light congestion considering the efficiency, time and cost. Therefore, using 98 data path to the tourism object with an average distance of 3.5 km this research

aims to find the fastest path using ants adaptive ACS method. The result is the value between 0.1 and 1 to produce the selection of paths that are more appropriate to the real conditions because of the variability of road density variables. With the influence of the number of ants on the ACS method, the fastest path solution is influenced by the length of the optimum distance, that is the closer the optimum distance is, the more the number of ants that affect. Thus the number of ants going through will change any time, and the selected route may change any time as well.

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