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Traveling Salesman Problem For Optimizing The Promotion Of Medical Devices In Pekanbaru City Hospital

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ABSTRACT

Travel from one place or location to place others taking into account the path or route the shortest one to go through in the case of traveling can be solved by the ant algorithm method. With the limited number of sales and efficiency in the medical equipment sales job, it is not uncommon for workers to do this experiencing various problems in the visited clients at the hospital, one of them the simple problem that is experienced is a problem time and cost efficiency in traveling. Not to mention the added limitations of the company's budget and time. and workers wish to visit multiple locations all at once. These time and cost efficiency issues are frequent happens because you don't know which path to go they traveled by selecting the best route by sales employees can at least minimize costs expenses for transportation and time wasted on Street. And the number of places you want to visit at various locations with different mileage make a decision which location want to go to. Ants algorithm find the most optimal path of all probability of the path the ant has taken with leaving pheromones in excess a lot. compared to paths that are not optimal. Result research shows that the optimal pathway with most pheromones are location route paths the shortest and optimum hospital.

Keyword Travelling; **Efficiency**; **ants algorithm**.

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1. INTRODUCTION

In 2020, COVID-19 began to spread in Indonesia(Olivia et al., 2020). This virus is claimed to have originated from Hubei, China(Atmojo & Nugroho, 2020) and began to spread throughout the world. This has resulted in panic, especially in the medical field. One of them is in terms of medical equipment such as masks, PPE and medicine. The covid-19 outbreak also resulted in the termination of work contracts due to lockdown policies in several cities such as Pekanbaru. This resulted in the company experiencing difficulties in carrying out operations. One of them is a company engaged in the field of medical equipment in the city of Pekanbaru. With limited space for sales and a minimum number of sales, efficiency is needed, especially in the use of transportation costs.

Traveling Salesman Problem or often abbreviated as TSP is a problem of finding a tour cycle that visits all cities exactly once in a given set of cities and returns to the hometown. To date, many researchers have tried to find approaches to solve CSR problems. One of them is using the Ant Colony Optimization (ACO) algorithm.

The ant colony optimization (ACO) algorithm is used to find the optimal path from the distance of a hospital in the city of Pekanbaru. from 7 different hospitals with varying distances from one place to another(Gülcü et al., 2018). This problem can also be called the traveling salesman problem (TSP)(Kalatjari & Talebpour, 2017). This problem, in principle, each ant leaves a pheromone substance on each path it is traversed (Chen et al., 2018), ACO calculates the number of pheromone substances left and which path is most often traversed so that the number of pheromones increases. In ACO, the ant movement can not be predicted which path to take. to get to the target location, then the probability value of each ant movement is calculated by the ACO algorithm (Melo et al., 2014). So that it is calculated which path has the shortest distance and is the most optimal for the path to the nearest hospital.

2. RESEARCH METHOD/MATERIAL AND METHOD/LETERATURE REVIEW

2.1. Traveling Salesman Problem

The traveling salesman problem starts to adopt the same problem as TSP, it's just more complicated where there are many people who travel or visit at several predetermined locations. In TSP problems, there is a problem where every salesperson makes a visit starting from the place of arrival and returning to the place of origin(Jiao et al., 2018).

2.2. Classification

One of the tasks that can be done with data mining is classification .The classification was first applied to plants that classify a particular species, such as those carried out by Carolus von Linne (also known as Carolus Linnaeus) who first classified species based on physical characteristics. Furthermore, he is known as the father of classification (Chan et al., 2020).

2.3. Ant Colony Optimization

Ant Colony Optimization (ACO) is a multi-agent search technique to solve combinatorial problems and other problems inspired by ant behavior in a colony(Sandeep Kumar & Prabhu, 2020). ACO comes from the behavior of the ants foraging from their cages to the food location. Ants forage by choosing a random path to the food location, then leaving a pheromone trail. The paths that are rarely traversed by ants pheromone slowly begin to decrease until it disappears, while the paths that are often traversed by ants pheromone values will increase(Ning et al., 2018).

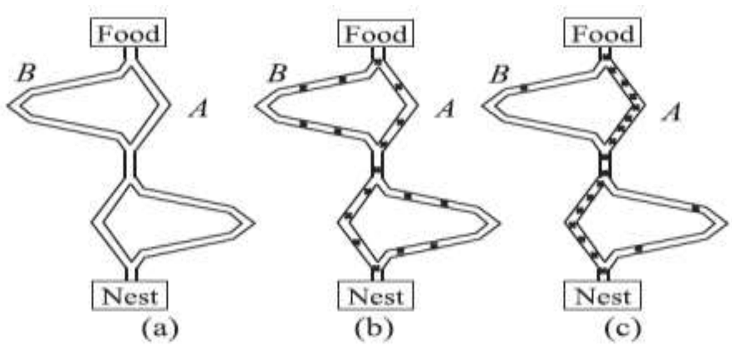

Figure 1. Ant Colony algorithm

ACO is applied to TSP cases with the problem of how to visit n locations to other locations with the minimum distance possible provided that one location can only be visited once (Risqiyanti & Rizkia, 2020). Here's how the ants can find the shortest path(Kabir et al., 2012).

- Each ant builds a solution from a randomly selected starting city.
- The next city is selected based on probability with a certain formula.
- Pheromone trail τ (i, j) defines the tendency to visit city j after visiting city i
- η (i, j) is the heuristic information used, namely the inverse comparison of the distance between city I and city j.
- Pheromone trail was revamped after every ant had visited the whole city.
- Pheromone trail will evaporate depending on parameter ρ (parameter evaporation)

When the system (the ant environment) has found the optimal solution, which is the shortest path, the ACO will be able to adapt quickly to the changes that occur around it. This adaptation is based on the pheromone which is the basis of ACO(Deng et al., 2019).
A strong pheromone will be owned by the solution with the most optimal path at the end of the algorithm. ACO in the process begins with ants individually having limited cognitive abilities and collectively being able to

find the shortest path between the food source and the nest. Suppose there are N ants in one colony. The ants begin the journey from the nest to the food source by passing through several points and ending at the end point of each cycle or iteration. If all the ants have completed their journey (Changdar et al., 2017).
the number of pheromones on the best tracks globally will be updated. The best global trajectory means the best among all the ants. At the start of the process, all fields from the starting point will be assigned the same number of pheromones. In the first iteration, all ants will start from the starting point and end at the last point by choosing points randomly. The optimization process ends when the maximum number of iterations has been reached or no better solution can be obtained in several successive iterations (Dong et al., 2018).

$$\Delta\tau_{i,j}^{k} = \begin{cases} 1/L_k \\ 0 \end{cases}$$

Information :

$\Delta\tau_{i,j}^{k}$ = Change of ant pheromone trail from location I to location j

Lk = The cost value of all the ants

The next step is updating each pheromone value to get a new pheromone value for the next iteration stage using equation [11]

$$\tau_{ij}(t+1) = \rho.\tau_{ij}(t) + \Delta\tau_{ij}$$

τij (t + 1) = trace value of pheromone on the next (new) iteration
τij (t) = pheromone trace value in the previous iteration (old)
ρ = pheromone trail evaporation constant
Δ (τij) = change of ant pheromone trail location i to

3. RESULTS AND DISCUSSION

In this study, the researchers chose 7 points for the location of the hospital. Where the dots represent the places. The selection of location points was chosen directly by 7 researchers by considering the location so that it can be easily recognized by the Google Map application. Based on the data obtained from the search results with the help of a directional tool on the Google Map, the mileage (km) from each point in the table can be arranged as follows:

Table 4.1. Mileage of each tourist location

Location Point (KM)	A	B	C	D	E	F	G
A	0	0,5	4.3	2.4	3.2	3.9	9.9
B	0,5	0	6.2	3.1	5.1	5.8	10.8
C	4.3	6.2	0	4.4	1.1	1.0	4.6
D	2.4	3.1	4.4	0	3.5	4.4	9.2
E	3.2	5.1	1.1	3.5	0	0,75	6.7
F	3.9	5.8	1.0	4.4	0,75	0	4.7
G	8.9	10.8	4.6	9.2	6.7	4.7	0

Furthermore, using the ant algorithm to get the shortest path (optimal). The first step is to initialize the price of the algorithm parameters, the parameters used are:

Alpha = 1.00
Beta = 1.00

Phi = 0.10
Many ants (k) = 7
Many ants (k) = 7

The stages in using the ant colony algorithm are:

1. Select the starting point, namely point V1
2. V1 has lines in V2, V3, V4, V5, V6, and V7, each with a distance of (0.5), (4.3), (2.4), (3.2), (3.9) and (9.9) then the distance is taken minimal or the smallest so that the chosen one is V7 so that the first path is obtained, namely V1 → V4
3. Do the same with the second step where starting from the selected point, namely V4. V4 has lines on V2, V3, V7, V5, and V6. Furthermore, the minimum or smallest distance is taken so that the chosen one is V5 so that the second path is obtained, namely V1 → V4 → V5
4. Do the same with the third step where starting from the selected point, namely V5. V5 has lines on V2, V3, V7, and V6. Then take the minimum or the smallest distance so that the chosen one is V3 so that the third path is obtained, namely V1 → V7 → V6 → V3
5. Do the same with the fourth step where starting from the selected point, namely V3. V3 has lines on V2, V7, and V5. Then take the minimum or the smallest distance so that the chosen one is V2 so that the fourth path is obtained, namely V1 → V7 → V6 → V3 → V2
6. Do the same with the fifth step where starting from the selected point, namely V2. V2 has a line on V7, and V5. Then take the minimum or the smallest distance so that the chosen one is V3 so that the fourth path is obtained, namely V1 → V7 → V6 → V3 → V2 → V4
7. Furthermore, because there are no more points, the last point is V5, so the line V1 → V7 → V6 → V3 → V2 → V4 → V5 is obtained. Because the Traveling Salesman Problem starts from the starting point and ends at the starting point as well, we get the line V1 → V7 → V6 → V3 → V2 → V4 → V5 so that the minimum distance of Cgreedy is 24.2.

from the Greedy algorithm above, the initial pheromone is obtained

$\tau_{i\,j} = \tau_0$ = 7 / 24.2 = 0.2892

The second step is to find the visibility value between points using a formula $\eta_{i\,j} = 1/d_{i\,j}$ where is the distance between the known points. So that you get:

In the same way, the visibility values between the points are obtained as follows:

Tabel 4.2. Inverse visibility between points

	A	B	C	D	E	F	G
A	0	2	0,232558	0,416667	0,3125	0,25641	0,10101
B	2	0	0,16129	0,322581	0,196078	0,172414	0,092593
C	0,2222	0,16129	0	0,227273	0,909091	1	0,217391
D	0,4167	0,322581	0,227273	0	0,285714	0,227273	0,108696
E	0,3125	0,196078	0,909091	0,285714	0	1,333333	0,149254
F	0,2564	0,172414	1	0,227273	1,333333	0	0,212766
G	0,1124	0,092593	0,217391	0,108696	0,149254	0,212766	0

The next step is to arrange an ant travel route to each location point. Ants that are distributed to all points will travel from the first point respectively as the point of origin and the other point as the point of destination. After that the ants travel randomly with the consideration that they have never been passed before. The journey of the ant continues until all points have been visited and form a path. The following is the probability calculation for the 1st cycle (NC = 1)

1st cycle (NC = 1)
1st ant (k1)
Taboo list = V1

$$P_{ij}^{k} = \begin{cases} \dfrac{[\tau_{ij}]^{\alpha}[\eta_{ij}]^{\beta}}{\sum_{u \epsilon j_r^k}[\tau_{ik}]^{\alpha}[\eta_i]^{\beta}} \end{cases}$$

Table 4.3. Probability of an Ant to 1 from point V1 to another location

	v1	v2	v3	v4	v5	v6	v7
V1	0	0.121609	0.112431	0.124142	0.108342	0.161049	0.372427
Commulative Probability	0	0.121609	0.234039	0.358182	0.466524	0.627573	1

Random numbers generated between 0-1 by using the Excel function, namely Rand (), then 0.65 is selected so that the selected point is V5 so that the Tabu list becomes V1 → V5. Do the same for the 2nd ant starting from point V2. After obtaining all the routes for the first ant journey, it can be arranged as in the following table:

Table 4.4. Ant Journey

Ant	Start Point	Probability V1	V2	V3	V4	V5	V6	V7	Choosen Point	Taboo List
K1	V1	0	2,23949423	0,260406	0,466561	0,349921	0,287115	0,113106	V3	V1→ V3
K2	V2	2,239494	0	0,180604	0,361209	0,219558	0,19306	0,10368	V7	V2→ V7
K3	V3	0,248833	0,18060437	0	0,254488	1,017952	1,119747	0,243423	V2	V3→ V2
K4	V4	0,466561	0,36120875	0,254488	0	0,319928	0,254488	0,121712	V7	V4→ V7
K5	V5	0,349921	0,21955826	1,017952	0,319928	0	1,492996	0,167126	V7	V5→ V7
K6	V6	0,287115	0,19305985	1,119747	0,254488	0,167126	0	0,238244	V5	V6→ V5
K7	V7	0,125814	0,10368029	0,243423	0,121712	0,167126	0,238244	0	V2	V7→ V2

The next step is to continue the second journey in the same way as before where the 1st ant (k1) starts from the selected point, in this case V3, the 2nd ant (k2) starts from point V7, the 3rd ant (k3) starting from point V2. 4th ant (k4) starts from point V7, 5th ant (k5) starts from point V7, 6th ant (k6) starts from point V5, 7th ant (k7) starts from point V2. Then the routes that have been visited in the taboo list are no longer used in the calculation.

Because all the objectives have been visited for the construction of the first cycle solution (NC = 1) and based on the understanding, the traveling salesman problem that starts from the starting point and ends at the starting point, it can be obtained a list of ant trips for the first cycle as follows:

Table 4.5. Ants Travel Routes and their Addition of Pheromones

ant	Taboo List	Lenght	Δi,k
K1	V1→ V3→V6→V4→V7→V2→V5	24,8	0,040323
K2	V2→ V7→V5→V4→V3→V1→V6	17,2	0,05814
K3	V3→ V2→V4→V7→V6→V1→V5	28,6	0,034965
K4	V4→ V7→V3→V5→V1→V76→V2	22,4	0,044643
K5	V5→V7→ V3→V2→V4→V1→V6	26,1	0,038314
K6	V6→ V5→ V2→V3→V1→V7→V4	25,7	0,038911
K7	V7→ V2→V3→V4→V2→V6→V1	26,4	0,037879

For the first cycle (NC = 1), the best route is obtained, namely the route taken by ant k1 with a route length of 18.6 km with the route V2 → V7 → V5 → V4 → V3 → V1 → V6. after information regarding the best route is obtained. Pheromone renewal will be carried out with the number of pheromones that were recently added of Δi, k = 0.05814

Because the first cycle has been completed and the pheromone renewal has been obtained, the next step is to find a better route in the second cycle. If there is a route that is better than the first cycle, in this case it has a smaller route length, the pheromone will be renewed again, but when the second cycle is not better than the first cycle, the route that is in the first cycle will be taken. Likewise for the third, fourth cycle and so on until it reaches the NC max or the specified iteration limit. In the manual search, it is only limited to the first cycle or the first iteration (NC = 1) so that the best temporary route is obtained, namely V2 → V7 → V5 → V4 → V3 → V1 → V6. with a distance of 17.2 km.

4. CONCLUSION

The formation of a TSP model for optimization using ACO and optimization of the path can be done by using the ant algorithm technique for 7 determined location points with the result of 17.2 KM and using the path V2 → V7 → V5 → V4 → V3 → V1 → V6.

So that based on the available data, it can be done to form the optimum path model for the shortest distance with the number of iterations 1 time. It takes the development of further research with the use of a greater number of iterations to get better results, as well as the addition of a larger number of tourist sites. It can also be expected that in the future the calculation of the ant algorithm will use several auxiliary applications such as mathlab or special software design that can make it easier to search for optimization paths.

REFERENCES

Atmojo, A. E. P., & Nugroho, A. (2020). EFL Classes Must Go Online! Teaching Activities and Challenges during COVID-19 Pandemic in Indonesia. *Register Journal*, *13*(1), 49–76. https://doi.org/10.18326/rgt.v13i1.49-76

Chan, A. S., Fachrizal, F., & Lubis, A. R. (2020). Outcome Prediction Using Naïve Bayes Algorithm in the Selection of Role Hero Mobile Legend. *Journal of Physics: Conference Series*, *1566*(1), 0–6. https://doi.org/10.1088/1742-6596/1566/1/012041

Changdar, C., Mahapatra, G. S., & Pal, R. K. (2017). A modified ant colony optimisation based approach to solve sub-tour constant travelling salesman problem. *International Journal of Mathematics in Operational Research*, *11*(3), 310–331. https://doi.org/10.1504/IJMOR.2017.087204

Chen, L., Xiao, C., Li, X., Wang, Z., & Huo, S. (2018). A seismic fault recognition method based on ant colony optimization. *Journal of Applied Geophysics*, *152*, 1–8. https://doi.org/10.1016/j.jappgeo.2018.02.009

Deng, W., Xu, J., & Zhao, H. (2019). An Improved Ant Colony Optimization Algorithm Based on Hybrid Strategies for Scheduling Problem. *IEEE Access*, *7*, 20281–20292. https://doi.org/10.1109/ACCESS.2019.2897580

Dong, X., Dong, W., & Cai, Y. (2018). Ant colony optimisation for coloured travelling salesman problem by multi-task learning. *IET Intelligent Transport Systems*, *12*(8), 774–782. https://doi.org/10.1049/iet-its.2016.0282
Gülcü, Ş., Mahi, M., Baykan, Ö. K., & Kodaz, H. (2018). A parallel cooperative hybrid method based on ant colony optimization and 3-Opt algorithm for solving traveling salesman problem. *Soft Computing*, *22*(5), 1669–1685. https://doi.org/10.1007/s00500-016-2432-3
Jiao, Z., Ma, K., Rong, Y., Wang, P., Zhang, H., & Wang, S. (2018). A path planning method using adaptive polymorphic ant colony algorithm for smart wheelchairs. *Journal of Computational Science*, *25*, 50–57. https://doi.org/10.1016/j.jocs.2018.02.004
Kabir, M. M., Shahjahan, M., & Murase, K. (2012). A new hybrid ant colony optimization algorithm for feature selection. *Expert Systems with Applications*, *39*(3), 3747–3763. https://doi.org/10.1016/j.eswa.2011.09.073
Kalatjari, V. R., & Talebpour, M. H. (2017). An improved ant colony algorithm for the optimization of skeletal structures by the proposed sampling search space method. *Periodica Polytechnica Civil Engineering*, *61*(2), 232–243. https://doi.org/10.3311/PPci.9153
Melo, L., Pereira, F., & Costa, E. (2014). Extended experiments with ant colony optimization with heterogeneous ants for large dynamic traveling salesperson problems. *Proceedings - 14th International Conference on Computational Science and Its Applications, ICCSA 2014*, 171–175. https://doi.org/10.1109/ICCSA.2014.39
Ning, J., Zhang, Q., Zhang, C., & Zhang, B. (2018). A best-path-updating information-guided ant colony optimization algorithm. *Information Sciences*, *433–434*, 142–162. https://doi.org/10.1016/j.ins.2017.12.047
Olivia, S., Gibson, J., & Nasrudin, R. (2020). Indonesia in the Time of Covid-19. *Bulletin of Indonesian Economic Studies*, *56*(2), 143–174. https://doi.org/10.1080/00074918.2020.1798581
Risqiyanti, V., & Rizkia, A. D. (2020). Pencarian Rute Terpendek Menggunakan Algoritma Ant Colony Optimization Pada Gui Matlab Guna Memantau Sustainable Development Goals. *Seminar Nasional Official Statistics*, *2019*(1), 31–38. https://doi.org/10.34123/semnasoffstat.v2019i1.193
Sandeep Kumar, M., & Prabhu, J. (2020). A hybrid model collaborative movie recommendation system using K-means clustering with ant colony optimisation. *International Journal of Internet Technology and Secured Transactions*, *10*(3), 337–354. https://doi.org/10.1504/IJITST.2020.107079

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