Ant Colony Optimization Algorithm Implementation for Distribution of Natural Disaster Relief Logistics in Jombang Regency Web Base

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Abstract. Ten sub-districts in Jombang, Indonesia, namely jombang downtown, Bareng, Wonosalam, Mojoagung, Mojowarno, Ploso, Kudu, Bandarkedungmulyo, Sumobito dan kesamben experience the impact of natural disasters of floods and landslides each year. All of these sub-districts consists of 32 villages. Disasters that become an annual routine, namely floods and landslides, make residents suffer moral and material losses. The Regional Disaster Management Agency (BPBD) is the main actor in helping this disaster such as donors who want to help the victims of natural disasters is accommodated by BPBD with the aim of equitable distribution of aid and on target. However, the practice in the field encountered obstacles namely not finding the shortest track from the location of the natural disaster to be visited in accordance with the track and logistics needs at the disaster site. The Ant Colony Optimization (ACO) algorithm is used by researchers to solve the problems encountered by Jombang BPBD. There are 6 iterations in implementing this algorithm. ACO algorithm test outcomes to find the track in the distribution of logistics to the disaster location that obtained the value of the number of ants 10, the initial pheromone of 0.117 from C greedy obtained 85.5 and the distance obtained from the google map. With the ACO algorithm found 3 alternatives for logistics distribution tracks in natural disaster areas in Jombang.

1. Introduction

Path search is mostly explained by other algorithms, such as the author who has conducted research in finding pathways for financial optimization using the asynchronous backtracking algorithm. However, in research in the distribution of logistics aid for natural disasters, it is unlikely that the author uses the asynchronous backtracking algorithm [1].

Natural disasters can occur at any time with or without natural signs. Natural disasters, especially in the Jombang area, often occur, namely floods and landslides which outcome in material and non-material losses. The impact of natural disasters then a post appeared to distribute logistical assistance, but the distribution outcomes did not go well because the track chosen was not right [2][3]. Finding the best track is time consuming and expensive. Currently the routing is integrated with all web-based and android-based platforms. Heuristic techniques are very helpful for optimization in finding the best and efficient track, which is often used is the theory of Ant Colony Optimization for track searches [4]. With the ant colony algorithm method is able to find the best distribution channel in distributing aid to certain areas [5].
2. ACO Theoretical

The Ant Colony Optimization (ACO) algorithm in principle is copying the activity of the ant colony, when the ants work together to locate the best track between the cage and the food place, several Strides are described to complete the track with the Ant Colony Optimization Algorithm. [6].

Stride 1

2.1. Initializes the nominal of algorithm variable.

The parameters to be initialized are:

a. The intensity of the intercity ant trails and their changes ($\tau_{ij}$)

b. The number of nodes (and) can be said to be the coordinates (x, y) or the distance between node i to vertex j

c. City of departure and destination node

d. The ant-rotation constant ($Q$)

e. The control constant for the intensity of the ant tracks ($\alpha$), the value $\alpha \geq 0$

f. Visibility control constant ($\beta$), value $\beta \geq 0$

g. Visibility between nodes $= 1 / d_{ij}(\eta_{ij})$

h. Many ants ($m$)

i. Ant trail volatilization constant, the value must be $> 0$ and $< 1$ for preventing Pheromone's infinite traces.

j. The number of rotation magnitudes (NCmax) is constant while the algorithm is running, and $\tau_{ij}$

will continue to change nominally every time the rotation of the algorithm starts from the first rotation (NC = 1) until the upper limit of rotation is reached (NC = NCmax) or until the convergence point there is.

k. 2.2. Each ant's first city initialization.

After a certain first initialization at random was done, then ($m$) ants were placed on the city.

Stride 2

1. Filling the first city entered the prohibition list. The outcomes of the first city initialization of each ant in Stride 1 must be filled in as the first element of the prohibition list.

2. The outcome of this Stride is to fill in the first element of the prohibition list of each ant with a specific city index.

3. Contain city indexes between 1 and n as initialized in Stride 1 ($k$).

Stride 3

preparation of the track of each ant's visit to each city ($s$). A collection of ants that have channeled to a nominal or each node, will start traveling from the initial node respectively as the origin node and one of the other vertices as the target city. Then from the second node gradually, the ant group will continue traveling by selecting one of the nodes that is not included in the list as the target of the next node. the departure of the ant pool gradually until all nodes have been fulfilled or have been assigned a ban. If there is a sequence of indexes that is skipped, the node is declared as prohibition ($k_s$) and the other vertex is said to be {N-tabuk}, then to decide the target node, the probability equation for the node to be skipped is used as follows:

$$P^k_j = \frac{(\tau_{ij})^\alpha (\eta_{ij})^\beta}{\sum_{s \in \{N - t a b_k\}} (\tau_{js})^\alpha (\eta_{js})^\beta} \text{ for } j \in \{N - t a b_k\}$$

$$P^k_j = 0, \text{ for another } j$$

Stride 4

a. Numeration of the track length of each ant.

Numeration of the length of the closed track (length closed tour) or Lk for each ant is done after one rotation is completed by all the ants. This Numeration is done based on each tabuk with the following equation:
b. Shortest track search. After calculating the $L_k$ for each ant, the minimum length of the closed track for each rotation or the overall L-min NC is or L-min.

c. The Numeration of the change in the intensity cost of the ant’s footmarks between nodes. The ant colony will leave footmarks on the inter-node trajectory in its path. The existence of volatilization and the difference in the number of ants that pass by, causes the possibility of changes in the intensity of the ant footmarks between nodes. The equation for this change is:

$$\Delta k_i = \sum_{k}^{m} \frac{\Delta k}{i,j}$$

$$\Delta k_{ij} = \frac{\tau_{ij}}{\xi_k} \text{ for } (i,j) \text{ city of origin and destination city in tableau} \xi$$

$$\Delta k_{ij} = 0 \text{ for another (i,j)}$$

Stride 5

a. Numeration of the intensity value of the ant footmarks between nodes for the rotation. Furthermore, the intensity value of ant footmarks between nodes on all trajectories between nodes may change due to volatilization and the difference in the number of ants that pass. For the next rotation, the ants that will pass through the trajectory have changed the intensity value. The intensity value of intercity ant footmarks (equation $\tau$) for the next rotation is calculated by:

$$\tau_{ij} = \rho \cdot \tau_{ij} + \Delta \tau_{ij}$$

b. Reset the cost for changes in the intensity of ant footmarks between nodes. For the next rotation, changes in the intensity of the cost of ant tracks between nodes need to be rearranged so that they have a value equal to zero.

Stride 6

Emptying the prohibition list, and repeating Stride 2. The prohibition list is necessary empty to be filled again with the new node order in the next rotation, if the maximum number of rotations has not been reached or convergence has not occurred. The algorithm is repeated from Stride 2 with the updated parameter values for the intensity of the intercity ant footmarks [6].

3. Empirical Study

There are 10 locations for the distribution of natural disaster relief, namely: Jombang, Bareng, Wonosalam, Mojowarno, Mojoagung, Ploso, Sumobito, Kudu, Bandar Gedung Mulyo and Kesamben and the author gets the distance value from each location the distribution between camps from the google map image as described in Figure 1 with a green line.
Figure 1. Google map image for distribution channels for natural disaster relief at each place in 10 sub-districts represented by a green line

The outcomes of the search for distance values with google map obtained the distance between locations as described in Figure 2. Tracing the value of distance between nodes.

Figure 2. Tracing the value of distance between nodes

The next Stride is to determine the destination city is used the probability equation for the city to be visited is as Figure 3.
Figure 3. the shortest value for each track

so the value of $C_{\text{greedy}}$ is 85.5 then the initial first fheromone ($\tau_0$) value is 0,117

the visibility value between location points is as describe figure 4. visibility Numeration outcome.

Figure 4. visibility Numeration outcome

The next Stride is to arrange an ant travel track to each pointlocation. Ants that are distributed to all points will travel from the point first respectively as the point of origin and the other as the point of destination. After that The ants travel randomly on the basis of never being passed previous. The journey of the ants continues until all points have been completed visited and formed a path. Here's a probability Numeration for the rotation and are shown in the cumulative probability at figure 5 Probability Cumulative.
Because the first rotation has been completed and the pheromone renewal is obtained, the next Stride is to find a better track in the second rotation, if there is a better track than the first rotation because it has a smaller track length then the pheromone will be renewed again, but if the second rotation is not better than the first rotation, the track that is in the first rotation will be taken. Likewise for the third, fourth and subsequent rotations until it reaches the NC max or the specified iteration limit and the final outcome is found after all processing until Pheromone 10 is found three best paths as shown figure 6. The track chosen.

Seeing from Figure 6, the selected tracks for the delivery of logistical aid for natural disasters were selected three tracks, namely:

**Track 1:**
From the city of Jombang to Bareng sub-district then to Wonosalam sub-district, then to Mojowarno sub-district then to Mojoagung sub-district then to Ploso sub-district then to Kudu sub-district then to Kudu sub-district then to Sumobito sub-district and finally to Bandar Kedung Mulyo sub-district.

**Track 2:**
From Bareng sub-district then to Jombang city then to Wonosalam sub-district then to Mojowarno sub-district then to Mojoagung sub-district then to Ploso sub-district then to Kesamben sub-district then to Kudu sub-district then to Sumobito sub-district and finally to a sub-district of Kota Kedungmulyo.

**Track 3:**
from Wonosalam sub-district then to kecamatan together then to Mojowarno kecamatan then to Mojoagung kecamatan then to Ploso sub-district then to kecamatan kesamben then to Kudu
kecataman then to Sumobito kecataman then to the city kecataman Kedung Mulyo and finally on the track back to the city of Jombang.

4. Conclusion
In this work, ACO is very effective in the search to determine more than 10 tracks of distribution of goods, because the more tracks visited, the complexity can be resolved heuristically. The more tracks, the more iterations, if done manually it is impossible to solve without heuristic-based mathematics. However, in this study it is less than perfect if the logistics distribution does not know the number of goods, whether they are still there or have not been around for a long time. Therefore, the researcher recommends further research that is integrated with supply chain management which can search for tracks based on the shortest track and the number of items that need to be stocked.

5. References
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