The selected metaheuristics algorithm to solve the Heterogeneous Vehicle Routing Problem (HVRP) is Ant Colony Optimization (ACO). HVRP involves simultaneously determining the composition and routing of a heterogeneous fleet of vehicles with varying capacities to serve a set of customers with known demand from a central depot. ACO is inspired by the methods used by the ants when exploring the environment to search for resources. At the beginning, the ants explore in a random way and lay pheromone on its way back to the colony when the path to the food is found. Other ants in the colony are more likely to follow the path with higher strength of pheromone and lay their own pheromone when they find the food as well. The pheromone will also evaporate over time so if the food is depleted the pheromone trail will be gone eventually. Therefore, with similar logics, if the path between nodes is shorter (or lower cost), then the pheromone trails will get stronger which the algorithm will be more likely to select the same node that yields better performance [3]. However, this is not sufficient to solve HVRP problems which involve the use of multiple types of vehicles. Therefore, the ACO is modified to have 2 stages during the construction of the solution to solve the HVRP problem. Firstly, the HVRP is decomposed into a set of sub-problems based on different types of vehicles where each sub-problem is then solved using traditional ACO. Hence, the algorithm involves customer allocation stage and route construction stage. Customer allocation stage allocates the customer to each type of vehicle where the route construction stage constructs the shortest path for each type of vehicle based on the customers it served [1].

A screenshot of a computer program

Description automatically generated

Figure 1: Customer Allocation Stage

The code above assigns the customer to each type of vehicle fleet based on the heuristic calculated which its formula can be found in [1]. The output of this function is the partitioned set of customers and the matrix which will be used to update the pheromone trails.

A screenshot of a computer program

Description automatically generated

Figure 2: Route Construction Stage

The code above constructs the shortest path for the partitioned set of customers based on the type of vehicle. For each partition, it selects the next route based on the heuristic scores which the formula can be found in [2]. The outcome of this logic is k (number of types of vehicles) routes constructed. After the construction of solution, the pheromone will be updated locally and globally based on the best global solution and iteration-best solution. This ensures that a better solution will be selected more likely due to higher level of pheromone.

A graph of blue bars

Description automatically generated with medium confidence

Figure 3: Histogram of Shortest Distances

After running the algorithm 50 times, the range of the minimum distance obtained by each function call is plotted in the histogram above. The range of the shortest path is between 94km and 104km.

A screenshot of a computer

Description automatically generated

Figure 4: Details of the Best Solution

The above is the best solution after iterating the algorithm 50 times where the shortest path constructed is 93.85 km.

References:

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