

Hybrid K-means and genetic algorithm approach for CVRPTW with heterogeneous vehicles and prioritized goods

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Abstract. The Capacitated Vehicle Routing Problem (CVRP) becomes significantly more complex when involving heterogeneous fleets, heterogeneous items, and delivery time window constraints (CVRPI-HFHTW). The novelty of this study lies in the strategy of allocating high-priority heterogeneous items (based on mass, volume, and predefined arrival times) into heterogeneous vehicles prior to route optimization. This study compares the effectiveness of K-Means Clustering and the Genetic Algorithm (GA) in allocating high-priority heterogeneous goods, followed by Genetic Algorithm-based route optimization to minimize fuel consumption across all heterogeneous vehicles. The simulation utilizes a dataset of 50 heterogeneous items (with variations of 5, 7 and 15 priority items) distributed across 5 heterogeneous vehicles.

The results show that the Genetic Algorithm-based allocation significantly outperforms K-Means. The Genetic Algorithm successfully distributes high-priority heterogeneous goods evenly across all vehicles, reduces the risk of delivery delays, decreases total travel distance by up to 32.48%, and significantly lowers overall fuel operational costs. Future research is recommended to explore alternative metaheuristic methods for high-priority heterogeneous item allocation strategies.

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