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# Route Optimization for E-Commerce Logistics Systems

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**Abstract:** *This paper aims to solve the last-mile distribution of rural e-commerce logistics (RECL) for the survival of third-party logistics enterprise. Considering the features of the RECL (long transport chain and low consumption density), A route optimization model is constructed for RECL's last-mile distribution to maximize the profit of the logistics enterprise, which is subsidized by the government. To solve the model, the ant colony optimization (ACO) was improved to suit the RECL's last-mile distribution by modifying the heuristic information, the update rule of pheromone, and the solution construction. Next, the optimal combinations of the default parameters in the improved ACO were determined through Matlab tests on test datasets in different sizes. The other parameters were configured according to the scale of the RECL. On this basis, the improved ACO was proved effective through example analysis on the said test datasets. The analysis results also react how the number of vehicles affects the maximum profit of the logistics enterprise and the coverage of the RECL logistics network.*

**Keywords:** Route Optimization, Ant Colony Optimization, Dijkstra Algorithm and Machine Learning

## I. INTRODUCTION

The rural area is becoming the new blue ocean for online consumption, triggering a boom in rural e-commerce logistics (RECL). Under the incentive policy, logistics enterprises start to set up outlets in easily accessible towns. However, the service network of most logistics enterprises has not yet covered villages, owing to their remote locations and poor transportation infrastructure. The existing research on last- mile distribution mainly focuses on densely populated areas like cities, communities and business areas. Last-mile delivery has become a critical source for market differentiation, motivating retailers to invest in a myriad of consumer delivery innovations, such as buy-online pickup-in-store, autonomous delivery solutions, lockers, and free delivery upon minimum purchase levels. Consumers care about last-mile delivery because it offers convenience and flexibility. For these reasons, same-day and on-demand delivery services are gaining traction for groceries, pre- prepared meals, and retail purchases. To meet customer needs, parcel carriers are increasing investments into urban and automated distribution hubs. However, there is a lack of understanding as to how best to design last-mile delivery models with retailers turning to experimentations that, at times, attract scepticism from industry observers

## II. LITERATURE REVIEW

In [1] Author considers Path planning is a very general problem in computer science and artificial intelligence and has many application areas such as robotics, computer games and artificial systems. In this paper they analyse 2D eight neighbour grid map, based on this property and Dijkstra's Algorithm. We can see that our improved Dijkstra's algorithm (IDA) speeds up the original Dijkstra's algorithm by several orders of magnitude and more.

In [2] Author tries to solve The Split Delivery Vehicle Routing Problem (SDVRP) problem has received much attention, solving this problem could actually reduce the cost. In this approach based on relaxed formulation allows a substantial improvement and much more. All the instances addressed in experiment from those 29 optimal solutions are found.

In [3] Author concerns with Orienteering problem are basically challenges in logistics, tourism and other field. In the orienteering problem, a set of vertices is given, each with a score. The goal is to determine a path, limited in length, that visits some vertices and maximises the sum of the collected scores. In this paper all the exact solution approaches and meta heuristic are discussed and compared.

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In [4] Authors has described an exact algorithm for solving a problem where the same vehicle performs several routes to serve a set of customers with time windows. A method based on an elementary shortest path algorithm with resource constraints is proposed to solve this problem. The method is divided into two phases: in the first phase, all non-dominated feasible routes are generated; in the second phase, some routes are selected and sequenced to form the vehicle workday.

In [5] Authors has explained how evolutionary game theory is used to analyse the evolution process of the information sharing behaviour between supply chain network enterprises with different penalties and information sharing risk costs. Analysis and agent-based simulation results show that when the amount of information between enterprises in supply chain networks is very large, it is difficult to form a sharing of cooperation; increase penalties, control cost sharing risk can increase the probability of supply chain information sharing network etc.

In [6] Authors has described that Since the logistics market is growing rapidly, the optimization of routing systems is of primary concern that motivates the use of vehicle routing problem (VRP) solvers as soft- ware components integrated as an optimization engine. In this a hybrid metaheuristic algorithm based on an ant colony system (ACS) and a variable neighbourhood search (VNS) is developed for its solution. The performance of the proposed ACS empowered VNS algorithm is studied on well- known benchmarks test problems taken from the open literature of VRPSPD for comparison purposes.

In,[7] Author modifies and improve a previously developed formulation of the talent scheduling problem; (2) Author develops a generalized variable neighbourhood search (GVNS) algorithm to solve the problem which has better performance than already developed algorithms in the literature especially for large-size instances. In order to evaluate our developed GVNS algorithm, we performed computational results using two benchmark data sets, named Types 1 and 2 The GVNS performs local searches to reach local optimum in addition to a shaking procedure to avoid getting trap in local optimum. Moreover, GVNS employs variable neighbourhood descent (VND) as a local search that systemically explores different neighbourhood structures.

In [8] this article proposes a discussion of three scenarios related to French e-grocery developments, and identifies and analyses the effect of new forms of proximity deliveries on household shopping trip flows. One of the objectives will be to consider logistics solutions adopted by online retailers. They present the two basic models of B2C: order-picking at a dedicated site and in-store picking. Second, they evaluate three distribution systems adopted by French e-grocery retailers.

In [9] authors work on ant colony optimization (ACO) approach as it is proposed for the team orienteering problem. Four methods, i.e., the sequential, deterministic-concurrent and random-concurrent and simultaneous methods, are proposed to construct candidate solutions in the framework of ACO. We compare these methods according to the results obtained on well-known problems from the literature. Finally, we compare the algorithm with several existing algorithms. The results show that our algorithm is promising these algorithms.

In [10] author presents a particle swarm optimization (PSO) method for determining the optimal proportional-integral derivative (PID) controller parameters to improve the step response of a third order system. In this paper, a PSO-based approach to optimally design a PID controller for a third order system is proposed. Instead of using evolutionary operators to manipulate the particle (individual), like in other evolutionary computational algorithms, each particle in PSO flies in the search space with velocity which is dynamically adjusted according to its own flying experience and its companions' flying experience. The Ziegler-Nichols tuning method is based on the determination of processes inherent characteristics such as the process gain, process time constant and process dead time. PSO based tuning methods have proved their excellence in giving better results by improving the steady state error, reduction in peak overshoot and settling time characteristics.

In [11] during the last decade nature inspired intelligence became increasing popular through the development and utilisation of intelligent paradigms in advanced information systems design. In this paper, the evolution of each individual of the total population, which consists of the parents and the offspring, is realized with the use of a Particle Swarm Optimizer where each of them has to improve its physical movement following the basic principles of Particle Swarm Optimization until it will obtain the requirements to be selected as a parent. In this paper instead of using a local search method to improve each individual separately, we use a global search method, Particle Swarm Optimization, and, thus, each individual does not try to improve its solution by itself but it uses knowledge from the solutions of the whole population. The most commonly used nature inspired methods for the solution of this problem are genetic algorithms, ant colony optimization, honey bees mating optimization,) and other evolutionary techniques.

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In [12] Vehicle routing problem (VRP) is an important and well-known combinatorial optimization problem encountered in many transports logistics and distribution systems. In this paper, we consider vehicle routing problem with simultaneous pickup and delivery (VRPSPD). Particle swarm Algorithm (PSO) and when a VND algorithm is used as a local search, the order of the neighbourhood structures affects the performance of the algorithm. Data set consists of 40 problem instances each of which has 50 customers. Instances are classified into four set, namely SCA3, SCA8, CON3 and CON8. SCA data sets are generated with customers scattered uniformly in the service region of 100*100. CON data sets are generated with half of the customers located uniformly in the service region and the other half are concentrated in the interval [100/3, 100/3]. In this paper, we proposed a hybrid search algorithm based on discrete particle swarm optimization (PSO) and variable neighbourhood descent algorithm (VND) to solve vehicle routing problem with simultaneous pickup and delivery

## III. Conclusion

Rural E-Commerce Logistics still faces many issues like Vehicle routing problem and issues in supply chain communication, high distribution cost, excess time requirement etc. The model was constructed based on the modelling practices for Route Optimization and Vehicle orientation problems. To solve the established model, the ACO was improved to suit the RECL's last-mile distribution by modifying the heuristic information the update rules of pheromone, solution construction and local search strategy. Besides, the optimal combination of the weight of heuristic factor, the weight of pheromone factor and pheromone volatility was determined through repeated tests on +ve test datasets. Meanwhile, the improved ACO was also varied on these test datasets. The results show that the improved ACO could provide a feasible routing plan for the RECL's last mile distribution. The research findings lay a solid basis for solving the last-mile distribution in the

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