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Simultaneously Pickup and Delivery Mdvrp with Multi Objective G.A

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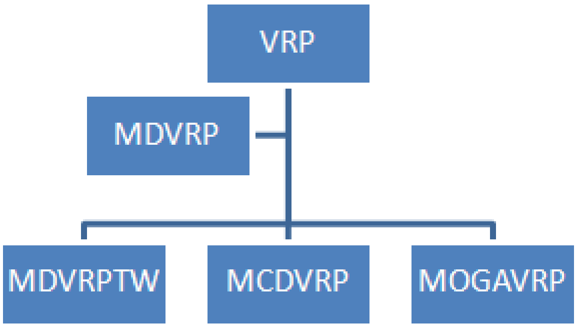
Abstract: This paper presents a multiple objective genetic algorithm for multi depot vehicle routing problem with simultaneously pickup and delivery (MDVRP-MOGA). MDVRP-MOGA is an expansion of VRP problems.MDVRP is a NP-hard problem which is more advantageous than VRP. MD-VRP simultaneously determines the routes for several vehicles from multiple depots to a set of customers and then return to the same depot. The objective of this problem is to find the routes for vehicles to service all the customers at a minimal cost which is in terms of number of routes and total travel distance without violating the capacity of the vehicles. A Multi objective Genetic Algorithm is provided to solve the proposed problem with new constraints.

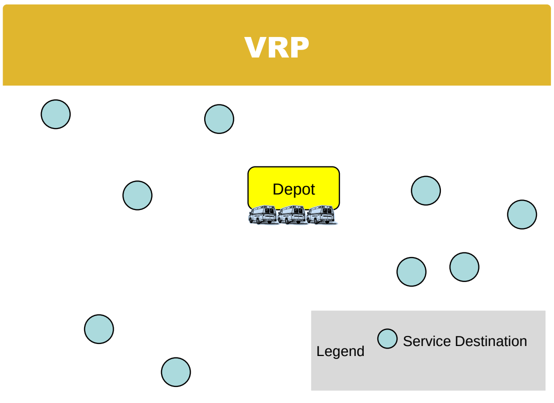
Keywords: VRP, MDVRP, Multi objective G.A.

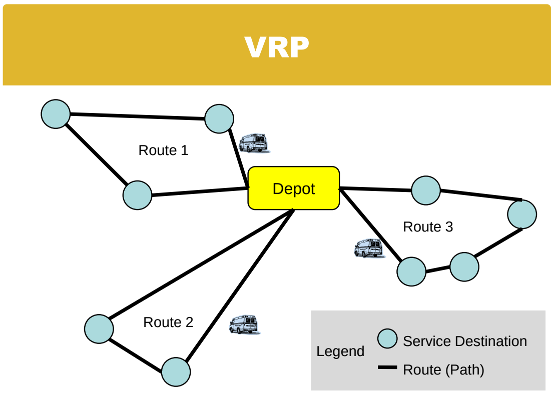
I. INTRODUCTION

Vehicle Routing Problem can be defined as the problem of designing routes for delivery vehicles (of known capacities) which are to operate from a single depot to supply a set of customers with known locations and known demands for a certain commodity. Routes for the vehicles are designed to minimize some objective such as the total distance travelled or total cost. The VRP is NP Hard problem, meaning that the computational effort required solving this problem increases exponentially with the problem size. VRP is further extended in following types of problems:

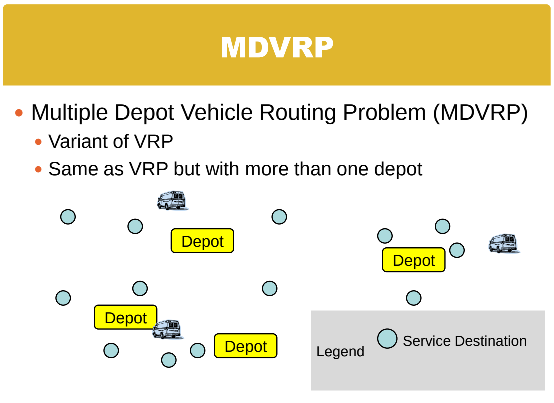


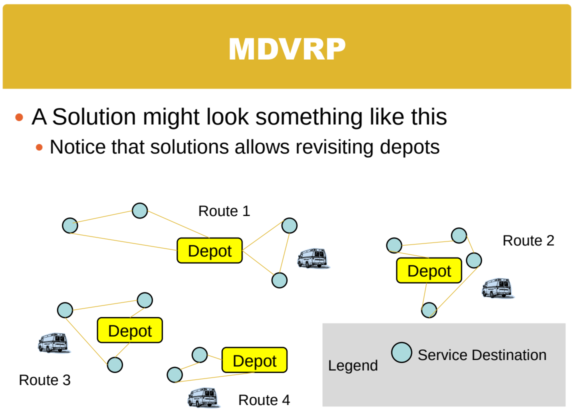
a. ***VRP:*** The Vehicle Routing Problem (VRP) is a generic name given to a set of problems in which set of routes for a fleet of vehicles based at one or several depots are to be formed for servicing the customers dispersed geographically. In the Vehicle Routing Problem (VRP), multiple vehicles leave from a single location (a "depot") and must return to that location after completing their assigned tours. The objective of the VRP is to form a route with lowest cost to serve all customers. Generally, distribution or collection of goods from customers to depot is called as VRP or Vehicle Scheduling Problem. In particular, the solution of a VRP calls for the determination of a set of routes, each performed by a single vehicle that starts and ends at its own depot, such that all the requirements of the customers are fulfilled, with some operational constraints and the global transportation cost is minimized. The operational constraints can be a vehicle capacity, route length, precedence relation between customers, etc.





b. ***MDVRP:*** The Multi-Depot Vehicle Routing Problem (MDVRP) is a generalization of the Single-Depot Vehicle Routing Problem (SDVRP). In the Multi Depot Vehicle Routing Problem (MDVRP), multiple vehicles leave from a multiple depots and must return to that depot, from where they leave, after completing their assigned tours. The objective of the MDVRP is to form a route with lowest cost to serve all customers from multiple depots. In general, the objective of the MDVRP is to minimize the total delivery distance or time spent in serving all customers. Lesser the delivery time, higher the customer satisfaction. Fewer vehicles mean that the total operation cost is less, thus the objective can also be minimizing the number of vehicles. Though there may be several objectives, the aim of MDVRP is to increase the efficiency of delivery. MDVRP proposed heuristic method comprises of two phases: route construction and vehicle dispatch. Routes are constructed by applying the Nearest Neighbor Procedure (NNP) to cluster customers and select a proper depot, Sweeping and Reordering Procedures (SRP) to generate initial feasible routes, and Insertion Procedure (IP) to improve routing. All of the previously mentioned extensions deal only with one single depot, therefore the field of VRP was enriched by the MDVRP class, which focuses on efficient routing algorithms that can handle multiple depot setups.





c. ***MDVRPTW:*** Other variants of the VRP are the VRP with split deliveries (SVRP), where customer orders can be carried out using more than one vehicle. This focuses on the multiple depot case with the addition of time windows (MDVRPTW), so that customers must be serviced out of several depots, under the same constraints that apply for the VRPTW. Therefore the vehicle routes have to be determined in a way that:

a) Each route starts and ends at the same depot.
b) All customer requirements are met exactly once by a vehicle.
c) The time windows for both customers and the depots are respected.
d) The sum of all requirements satisfied by any vehicle does not exceed its Capacity.
e) The total cost is minimized.

d. ***MOGA-VRP:*** The Multi Objective Genetic Algorithm Vehicle Routing Problem gives rise to a set of optimal solutions (largely known as Pareto-optimal solutions), instead of a single optimal solution. In the absence of any further information, one of these Pareto-optimal solutions cannot be said to be better than the other. This demands a user to find as many Pareto-optimal solutions as possible. Classical optimization methods (including the multicriterion decision-making methods) suggest converting the multiobjective optimization problem to a single-objective optimization problem by emphasizing one particular Pareto-optimal solution at a time. When such a method is to be used for finding multiple solutions, it has to be applied many times, hopefully finding a different solution at each simulation run. The nondominated sorting genetic algorithm (NSGA) was one of the first such EAs. An improved version of NSGA, which we call NSGA-II, is best for finding the better solution in MOGA-VRP.

e. ***Multi Capacitated Depot VRP:*** In Multi Capacitated Depot VRP (MCD-VRP), capacity of all vehicles is considered identical. Each Depot in this problem has a specific capacity. In this, at a given time a customer can just only deliver a product or Pick up a product. The cost function in this problem is looking for minimizing four kinds of costs: traveling costs, the fixed costs of using depots, the fixed cost of using vehicles and finally the penalty cost of passing the time window. The main goal is minimizing the traveling costs.

f. ***MDVRP with pickup and delivery:*** It consider a multi depot vehicle routing problem with pickup and delivery requests. In the problem of interest, each location may have goods for both pickup and delivery with multiple delivery locations that may not be the depots. These characteristics are quite common in industrial practice. A partical swarm optimization algorithm with multiple social learning structures are proposed for solving the practical case of multi depot vehicle routing problem with simultaneous pickup and delivery. A new decoding procedure is implemented using the PSO class provided in the ETLib object library. Computational experiments are carried out using the test instances for the pickup and delivery problem with a newly generated instance. The preliminary results show that the proposed algorithm is able to provide good solution to most of the test problems.

II. RELATED WORK

a. ***HVRP:*** HVRP problems were first introduced by **Taillard [1]** who presented a heuristic column generation method. **Prins [2]** developed a heuristic for solving the HVRP with dependent routing costs (HVRPD) by extending a series of VRP classical heuristics and incorporating a local search procedure based on the Steepest Descent Local Search and Tabu Search (TS). **Tarantilis et al. [3] [4]**developed list-based and backtracking threshold accepting algorithm for solving the same problem. Three years later, **(Li et al. [5]** developed a similar algorithm called HRTR, based on the algorithm Record-To-Record (RTR). **Prins [6]** developed two heuristic procedures based on a Memetic Algorithm for the HVRPD. **Eguia et al. [7],** proposes a linear programming mathematical model of the HVRP with time windows and backhauls (HVRPTW-B) internalizing external cost.

b. ***VRPTW:*** The **Braysy [8]** gave the internal design of the VND and RVNS algorithm in detail, analyzed VRPTW problem, indicated the VND algorithm was one of the most effective ways to solve VRPTW problems. **Polacek [9]** designed VNS to solve MDVRPTW, the algorithm used the neighborhood structure of swap and cross to do shaking operation for the current solution. **Goel and Gruhn [10]** introduced the RVNS to solve the general VRP problem including time windows, vehicle constraints, path constraints, travel departure time constraints, capacity constraints, the order models compatibility constraints, multi-supplier point of the orders, transport and service position constraints**. Fleszar [11]** adopted VNS algorithm to solve the open-loop VRP problem, and tested 16 benchmark problems.

c. ***MDVRPTW:*** **Wen *et al.* [12]** developed an improved particle swarm algorithm for solving MDVRPTW. **Ting *et al.* [13]** combined the ant colony algorithm and simulated annealing algorithm to solve MDVRPTW and got ideal experimental results. **Ostertag [14]** integrated the VNS and MA into POPMUSIC algorithm framework International Journal of Control and Automation. **Dondo, *et al.* [15]** proposed a hybrid local improvement algorithm to solve large scale MDVRPTW. **Andrea Bettinelli *et al.* [16]** presented a branch-and-cut-and-price algorithm for the exact solution of a variation of the vehicle routing problem with time windows in which the transportation fleet is made by vehicles with different capacities and fixed costs, based at different depots. **Sutapa *et al.* [17]** analyzed the underlying complexities of MDPVRPTW and presented a heuristic approach to solve the problem, in this algorithm, two modification operators namely, crossover and mutation are designed specially to solve the MDPVRPTW. **Anand [18]** proposed hybrid algorithm which was composed by an Iterated Local Search (ILS) based heuristic and a Set Partitioning (SP) formulation to solve the Heterogeneous Fleet Vehicle Routing Problem. **Salhi *et al.* [19]** dealed with the fleet size and mix vehicle routing problem with backhauls (FSMVRPB) based on the ILP formulation

III. PROBLEM DESCRIPTION

The problem arises as follows: “Being given:

a. A set of customers divided geographically on a vast territory and expressing a strong demand of fuel
b. A heterogeneous fleet of vehicles initially parked on a set of depots
c. A set of removal sites on which vehicles come to be supplied in order to serve the customers.

The objective is to find vehicle tours of optimal costs that start and end on the same depot and which satisfy the demands of all the customers as well as other operational constraints.”

A. Problem characteristics:

The fleet of vehicle has the following characteristics:

a. It is about a heterogeneous fleet: it consists of vehicles of various capacities.
b. It consists of vehicles owned by the company and rented vehicles. Each vehicle has an associated use cost which is definitely less important for a vehicle of the company than for a rented vehicle. Hence, the imperative to give priority to the use company vehicles.
c. The vehicles of the fleet are non-compartmentalized, without voltmeters and leave fully a removal site towards a customer to unload the integrality of their capacity.
d. The travel time of a vehicle shall not exceed the 8 hours prescribed by the regulations governing the work of drivers.

IV. TOOL USED (MATLAB)

MATLAB (**mat**rix **lab**oratory) is a multi-paradigm numerical computing environment and fourth-generation programming language. Using matlab, you can analyse data, develop algorithms and create models and applications. Developed by Math Works, MATLA Ballows matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs written in other languages, including C, C++, Java,Fortran and Python.

Although MATLAB is intended primarily for numerical computing, an optional toolbox uses the MuPAD symbolic engine, allowing access to symbolic computing capabilities. An additional package, Simulink, adds graphical multi-domain simulation and Model-Based Design for dynamic and embedded systems. In 2004, MATLAB had around one million users across industry and academia. MATLAB users come from various backgrounds of engineering, science and economics. MATLAB is widely used in academic and research institution as well as industrial enterprises.

V. CONCLUSION

In this paper we conclude that MDVRP find routes for vehicles to service all the customers at a minimal cost in terms of number of routes and total travel distance, without violating the capacity of the vehicles. Each vehicle initially is in a specific depot; it starts moving from that depot, services the customer and again will return to the same depot. Each depot has its specific capacity and the sum of orders in routes related to a depot will not exceed its maximum capacity. Multi objective genetic algorithm uses the NSGA-II which is able to maintain a better spread of solutions from multiple objective. Better results will be find out with the help of MD-VRP-MOGA.

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