



Vehicle Routing Problem

**Bruce Golden, Xingyin Wang, Edward
Wasil**

Vehicle Routing Problem:

Vehicle Routing Paolo Toth, Daniele Vigo, 2014-12-05 Vehicle routing problems among the most studied in combinatorial optimization arise in many practical contexts freight distribution and collection transportation garbage collection newspaper delivery etc Operations researchers have made significant developments in the algorithms for their solution and Vehicle Routing Problems Methods and Applications Second Edition reflects these advances The text of the new edition is either completely new or significantly revised and provides extensive and complete state of the art coverage of vehicle routing by those who have done most of the innovative research in the area it emphasizes methodology related to specific classes of vehicle routing problems and since vehicle routing is used as a benchmark for all new solution techniques contains a complete overview of current solutions to combinatorial optimization problems It also includes several chapters on important and emerging applications such as disaster relief and green vehicle routing

The Vehicle Routing Problem: Latest Advances and New Challenges Bruce L. Golden, S. Raghavan, Edward A. Wasil, 2008-07-20 Theoretical research and practical applications in the field of vehicle routing started in 1959 with the truck dispatching problem posed by Dantzig and Ramser 1 and the optimum routing of a fleet of gasoline delivery trucks between a bulk terminal and a large number of service stations supplied by the terminal Using a method based on a linear programming formulation their hand calculations produced a near optimal solution with four routes to a problem with twelve service stations The authors proclaimed No practical applications of the method have been made as yet In the nearly 50 years since the Dantzig and Ramser paper appeared work in the field has exploded dramatically Today a Google Scholar search of the words vehicle routing problem VRP yields more than 21 700 entries The June 2006 issue of OR MS Today provided a survey of 17 vendors of commercial routing software whose packages are currently capable of solving average size problems with 1 000 stops 50 routes and two hour hard time windows in two to ten minutes 2 In practice vehicle routing may be the single biggest success story in operations research For example each day 103 500 drivers at UPS follow computer generated routes The drivers visit 7 9 million customers and handle an average of 15 6 million packages 3

The Evolution of the Vehicle Routing Problem Bruce Golden, Xingyin Wang, Edward Wasil, 2022-12-18 This book presents state of the art research and practice in optimization routing specifically the vehicle routing problem VRP Since its introduction in the late 1950s the VRP has been a very significant area of research and practice in operations research Vehicles are used to make deliveries and for pick ups every day and everywhere Companies such as Amazon UPS FedEx and DHL use route optimization to reduce mileage fuel use number of trucks on the road and carbon dioxide emissions The authors compile and analyze 135 survey and review articles on vehicle routing topics published between 2005 and 2022 in an effort to make key observations about publication and trend history summarize the overall contributions in the field and identify trends in VRP research and practice The authors have compiled published research on models algorithms and applications for specific areas including alternative and multiple objectives arc routing

and general routing drones last mile delivery and urban distribution dynamic and stochastic routing green routing inventory routing loading constraints location routing multiple depots pickup and delivery and dial a ride problems rich and multi attribute routing routing over time shipping two echelon collaborative and inter terminal problems specific variants benchmark datasets and software and exact algorithms and heuristics In addition the book discusses how vehicle routing problems are among the most widely studied problems in combinatorial optimization due to the mathematical complexity and practical significance

Metaheuristics for Vehicle Routing Problems Nacima Labadie, Christian Prins, Caroline Prodhon, 2016-02-11 This book is dedicated to metaheuristics as applied to vehicle routing problems Several implementations are given as illustrative examples along with applications to several typical vehicle routing problems As a first step a general presentation intends to make the reader more familiar with the related field of logistics and combinatorial optimization This preamble is completed with a description of significant heuristic methods classically used to provide feasible solutions quickly and local improvement moves widely used to search for enhanced solutions The overview of these fundamentals allows appreciating the core of the work devoted to an analysis of metaheuristic methods for vehicle routing problems Those methods are exposed according to their feature of working either on a sequence of single solutions or on a set of solutions or even by hybridizing metaheuristic approaches with others kind of methods

Bio-inspired Algorithms for the Vehicle Routing Problem Francisco Baptista Pereira, Jorge Tavares, 2008-09-29 The vehicle routing problem VRP is one of the most famous combinatorial optimization problems In simple terms the goal is to determine a set of routes with overall minimum cost that can satisfy several geographical scattered demands Biological inspired computation is a field devoted to the development of computational tools modeled after principles that exist in natural systems The adoption of such design principles enables the production of problem solving techniques with enhanced robustness and flexibility able to tackle complex optimization situations The goal of the volume is to present a collection of state of the art contributions describing recent developments concerning the application of bio inspired algorithms to the VRP Over the 9 chapters different algorithmic approaches are considered and a diverse set of problem variants are addressed Some contributions focus on standard benchmarks widely adopted by the research community while others address real world situations

The Vehicle Routing Problem Paolo Toth, Daniele Vigo, 2002 In the field of combinatorial optimization problems the Vehicle Routing Problem VRP is one of the most challenging Defined more than 40 years ago the problem involves designing the optimal set of routes for fleets of vehicles for the purpose of serving a given set of customers Interest in VRP is motivated by its practical relevance as well as its considerable difficulty

The Periodical Vehicle Routing Problem: Research Overview and Practical Application to a South German Fast Food Restaurant Claus Friedrich, 2006-03-29 Diploma Thesis from the year 2005 in the subject Business economics General grade 1.3 University of Augsburg language English abstract In the middle of May 1997 Gerd Raupeter CEO of McDonald s Deutschland Inc Mc Donald s Germany Inc had to announce that

some restaurants were sold out of shrimps¹ The keen customer's demand for this kind of seafood already exceeded the expected forecasts one week after starting the ongoing Fisch Wochen fish weeks mission As these circumstances highlighted an accurate product choice for the fast food corporation Mr Raupeter has nevertheless been pleased about it Otherwise such an awkward situation could be prevented by developing a demand driven scheduling for each restaurant in the future The Periodic al Vehicle Routing Problem PVRP seems to be a tailor made solution for the reason that exact planning has to be done and delivery routes must be constructed over a period of time for example multiple days Observations and analyzes in the literature in most of the industries deal with a constant demand for goods and with only one good Moreover the one of a kind client prevails But for the application of the PVRP to the gastronomy there are some exceptions to be considered As this paper presents a solution approach of the delivery problem for the fast food industry in South Germany there are products to be transported consisting of diverse components Although there are nearly identical opening hours the eating places the clientele to be delivered due to their irregular demand for food and beverages are varying from the unique purchaser Another singularity lies in the conformity of the foodstuff which is reflected in the comparability of each restaurant Therefore the enduring solution approach will be done in a sample of some fast food restaurants This paper herein is organized as follows In the second and third chapter various theories that could lead depots how to organize its delivery are reviewed with an emphasis on the Vehicle Routing Problem VRP as well as the PVRP

Green Transportation and New Advances in Vehicle Routing Problems Houda Derbel,Bassem Jarbouï,Patrick Siarry,2020-12-08 This book presents recent work that analyzes general issues of green transportation The contributed chapters consider environmental objectives in transportation including topics such as battery swap stations for electric vehicles efficient home healthcare routing waste collection and various vehicle routing problems The content will be valuable for researchers and postgraduate students in computer science operations research and urban planning

Orienteering Problems Pieter Vansteenwegen,Aldy Gunawan,2019-08-30 This tutorial introduces readers to several variants of routing problems with profits In these routing problems each node has a certain profit and not all nodes need to be visited Since the orienteering problem OP is by far the most frequently studied problem in this category of routing problems the book mainly focuses on the OP In turn other problems are presented as variants of the OP focusing on the similarities and differences The goal of the OP is to determine a subset of nodes to visit and in which order so that the total collected profit is maximized and a given time budget is not exceeded The book provides a comprehensive review of variants of the OP such as the team OP the team OP with time windows the profitable tour problem and the prize collecting travelling salesperson problem In addition it presents mathematical models and techniques for solving these OP variants and discusses their complexity Several simple examples and benchmark instances together with their best known results are also included Finally the book reviews the latest applications of these problems in the fields of logistics tourism and others

Models for Practical Routing Problems in Logistics S. P. Anbuudayasankar,K.

Ganesh, Sanjay Mohapatra, 2014-07-08 This book deals with complex variants of Travelling Salesman Problem TSP and Vehicle Routing Problem VRP within the manufacturing and service industries The objective is to develop heuristics for these supply chain problems in order to offer practical solutions to improve operational efficiency These heuristics are evaluated using benchmark and derived data sets Case studies pertaining to logistics in different industries including textile machinery manufacturing and banking are also included to demonstrate the created heuristics High competition in today's global market has forced the organizations to invest in and focus on their logistics system The critical function of logistics is the transportation within and across various supply chain entities Both supply and distribution procedure require effective transportation management A small improvement in routing problems can lead to huge logistics savings in absolute terms This book should appeal to executives researchers and consultants seeking supply chain management solutions **Online Vehicle Routing** Luis M. Torres, 2004 **Exact Algorithms for the Vehicle Routing Problem** Laporte, Gilbert, Nobert, Yves, Université de Montréal. Centre de recherche sur les transports, Université du Québec à Montréal. Centre de recherche en gestion, École des hautes études commerciales (Montréal, Québec). Groupe d'études et de recherche en analyse des décisions, 1985 The State of the Art in the Routing and Scheduling of Vehicles and Crews, 1981 Arc Routing Angel Corberan, Gilbert Laporte, 2014-12-01 This book provides a thorough and up to date discussion of arc routing by world renowned researchers Organized by problem type the book offers a rigorous treatment of complexity issues models algorithms and applications Arc Routing Problems Methods and Applications opens with a historical perspective of the field and is followed by three sections that cover complexity and the Chinese Postman and the Rural Postman problems the Capacitated Arc Routing Problem and routing problems with min max and profit maximization objectives and important applications including meter reading snow removal and waste collection *The Vehicle Routing Problem on Tree Networks* Roshan Kumar, 2011 The Vehicle Routing Problem VRP is a classical problem in logistics that has been well studied by the operations research and transportation science communities VRPs are defined as follows Given a transportation network with a depot a set of pickup or delivery locations and a set of vehicles to service these locations find a collection of routes starting and ending at the depot such that i the customer's demand at a node is satisfied by exactly one vehicle ii the total demand satisfied by a vehicle does not exceed its capacity and iii the total distance traveled by the vehicles is minimized This problem is especially hard to solve because of the presence of sub tours which can be exponential in number In this dissertation a special case of the VRP is considered where the underlying network has a tree structure TVRP Such tree structures are found in rural areas river networks assembly lines of manufacturing systems and in networks where the customer service locations are all located off a main highway Solution techniques for TVRPs that explicitly consider their tree structure are discussed in this dissertation For example TVRPs do not contain any sub tours thereby making it possible to develop faster solution methods The variants that are studied in this dissertation include TVRPs with Backhauls TVRPs with Heterogeneous Fleets

TVRPs with Duration Constraints and TVRPs with Time Windows Various properties and observations that hold true at optimality for these problems are discussed Integer programming formulations and solution techniques are proposed Additionally heuristic methods and conditions for lower bounds are also detailed Based on the proposed methodology extensive computational analysis are conducted on networks of different sizes and demand distributions

Distance-constrained Vehicle Routing Problem Samira Almoustafa,2013 The asymmetric distance constrained vehicle routing problem ADVRP looks at finding vehicle tours to connect all customers with a depot such that the total distance is minimised each customer is visited once by one vehicle every tour starts and ends at a depot and the travelled distance by each vehicle is less than or equal to the given maximum value We present three basic results in this thesis In the first one we present a general flow based formulation to ADVRP It is suitable for symmetric and asymmetric instances It has been compared with the adapted Bus School Routing formulation and appears to solve the ADVRP faster Comparisons are performed on random test instances with up to 200 customers We reach a conclusion that our general formulation outperforms the adapted one Moreover it finds the optimal solution for small test instances quickly For large instances there is a high probability that an optimal solution can be found or at least improve upon the value of the best feasible solution found so far compared to the other formulation which stops because of the time condition This formulation is more general than Kara formulation since it does not require the distance matrix to satisfy the triangle inequality The second result improves and modifies an old branch and bound method suggested by Laporte et al in 1987 It is based on reformulating a distance constrained vehicle routing problem into a travelling salesman problem and uses the assignment problem as a lower bounding procedure In addition its algorithm uses the best first strategy and new branching rules Since this method was fast but memory consuming it would stop before optimality is proven Therefore we introduce randomness in choosing the node of the search tree in case we have more than one choice usually we choose the smallest objective function If an optimal solution is not found then restart is required due to memory issues so we restart our procedure In that way we get a multistart branch and bound method Computational experiments show that we are able to exactly solve large test instances with up to 1000 customers As far as we know those instances are much larger than instances considered for other VRP models and exact solution approaches from recent literature So despite its simplicity this proposed algorithm is capable of solving the largest instances ever solved in literature Moreover this approach is general and may be used in solving other types of vehicle routing problems In the third result we use VNS as a heuristic to find the best feasible solution for groups of instances We wanted to determine how far the difference is between the best feasible solution obtained by VNS and the value of optimal solution in order to use the output of VNS as an initial feasible solution upper bound procedure to improve our multistart method Unfortunately based on the search strategy best first search using a heuristic to find an initial feasible solution is not useful The reason for this is because the branch and bound is able to find the first feasible solution quickly In other words in

our method using a good initial feasible solution as an upper bound will not increase the speed of the search. However, this would be different for the depth first search. However, we found a big gap between VNS feasible solution and an optimal solution, so VNS can not be used alone unless for large test instances when other exact methods are not able to find any feasible solution because of memory or stopping conditions.

Smart Delivery Systems Jakub Nalepa, 2019-11-21. Smart Delivery Systems Solving Complex Vehicle Routing Problems examines both exact and approximate methods for delivering optimal solutions to rich vehicle routing problems showing both the advantages and disadvantages of each approach. It shows how to apply machine learning and advanced data analysis techniques to improve routing systems familiarizing readers with the concepts and technologies used in successfully implemented delivery systems. The book explains both the latest theoretical and practical advances in intelligent delivery and scheduling systems and presents practical applications for designing new algorithms for real life scenarios.

A Route-splitting Approach to the Vehicle Routing Problem and a Lotsizing and Scheduling Problem with Sequence-dependent Setup Costs Sungmin Kang, 1994

A Perturbation Metaheuristic for the Vehicle Routing Problem with Private Fleet and Common Carriers Bolduc, Marie-Claude, Université Laval. Faculté des sciences de l'administration. Direction de la recherche, 2006. The purpose of this article is to propose a perturbation metaheuristic for the Vehicle Routing Problem with Private fleet and Common carrier VRPPC. This problem consists of serving all customers such in a way that 1 each customer is served exactly once either by a private fleet vehicle or by a common carrier vehicle 2 all routes associated with the private fleet start and end at the depot 3 each private fleet vehicle performs only one route 4 the total demand of any route does not exceed the capacity of the vehicle assigned to it and 5 the total cost is minimized. This article describes a new metaheuristic for the VRPPC which uses a perturbation procedure in the construction and improvement phases and also performs exchanges between the sets of customers served by the private fleet and the common carrier. Extensive computational results show the superiority of the proposed metaheuristic over previous methods.

Heuristics for the vehicle routing problem with multiple deliverymen Michael Huemer, 2013-09-02. Masterarbeit aus dem Jahr 2011 im Fachbereich BWL - Beschaffung, Produktion, Logistik. Note: Sehr gut. Karl Franzens Universität Graz. Produktion und Logistik. Sprache: Deutsch. Abstract: Der Hauptbestandteil dieser Arbeit ist das Testen verschiedener lokaler Suchoperatoren für eine Erweiterung des gutbekannten Vehicle Routing Problems. Diese erst vor kurzem eingeführte Erweiterung wurde notwendig um ein Routenplanungsproblem zu lösen, das daraus bestand Getrönke und Tabakwaren in dichtbesiedelten Großstädten in Brasilien auszuliefern. Es wurde nun versucht herauszufinden, welche der VRPTW Operatoren geeignet sind um das Vehicle Routing Problem with Time Windows and Multiple Deliverymen VRPTWMD möglichst gut zu lösen. Insgesamt wurden vier Operatoren implementiert, wobei Relocate und Ejection Chains auf die Routenminimierung abzielen und Cross bzw. 2-Opt entsprechend die gefahrene Distanz verringern sollten. Um die Operatoren zu testen wurden die besten Startlösungen mit der von Solomon entwickelten I1

Ein heuristischer Algorithmus generiert die Erkenntnisse aus den Tests wurden schließlich dazu verwendet eine best performance Variante zu entwickeln welche anhand der Solomon Instanzen R101 bis R112 getestet wurde Die Ergebnisse der Tests befinden sich am Ende der Arbeit The Vehicle Routing Problem with time windows is a well studied problem in literature The extension to Vehicle Routing Problem with Time Windows and Multiple Deliverymen VRPTWMD has been proposed to solve a delivery problem of commodities like beverages and tobacco in highly populated areas in Brazil This rather new problem structure in the VRPTW context is the main subject of the work In this thesis the aim is to find out which operators used for VRP are most suitable for the VRPTWMS Relocate and Ejection Chain operators were tested for truck and deliverymen reduction Cross and 2 opt were implemented to reduce distance The Solomon I1 insertion heuristic was used to obtain starting solutions for the tests and the final version of the algorithm proposed To complete this work several tests have been performed and the results of the algorithm running Solomon R101 R112 instances can be found at the end

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Table of Contents Vehicle Routing Problem

1. Understanding the eBook Vehicle Routing Problem
 - The Rise of Digital Reading Vehicle Routing Problem
 - Advantages of eBooks Over Traditional Books
2. Identifying Vehicle Routing Problem
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Vehicle Routing Problem
 - User-Friendly Interface
4. Exploring eBook Recommendations from Vehicle Routing Problem

- Personalized Recommendations
 - Vehicle Routing Problem User Reviews and Ratings
 - Vehicle Routing Problem and Bestseller Lists
5. Accessing Vehicle Routing Problem Free and Paid eBooks
 - Vehicle Routing Problem Public Domain eBooks
 - Vehicle Routing Problem eBook Subscription Services
 - Vehicle Routing Problem Budget-Friendly Options
 6. Navigating Vehicle Routing Problem eBook Formats
 - ePub, PDF, MOBI, and More
 - Vehicle Routing Problem Compatibility with Devices
 - Vehicle Routing Problem Enhanced eBook Features
 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Vehicle Routing Problem
 - Highlighting and Note-Taking Vehicle Routing Problem
 - Interactive Elements Vehicle Routing Problem
 8. Staying Engaged with Vehicle Routing Problem
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Vehicle Routing Problem
 9. Balancing eBooks and Physical Books Vehicle Routing Problem
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Vehicle Routing Problem
 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
 11. Cultivating a Reading Routine Vehicle Routing Problem
 - Setting Reading Goals Vehicle Routing Problem
 - Carving Out Dedicated Reading Time
 12. Sourcing Reliable Information of Vehicle Routing Problem

-
- Fact-Checking eBook Content of Vehicle Routing Problem
 - Distinguishing Credible Sources
13. Promoting Lifelong Learning
- Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
- Integration of Multimedia Elements
 - Interactive and Gamified eBooks

Vehicle Routing Problem Introduction

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