Routing problems: A bibliography

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This bibliography contains 500 references on four classical routing problems: the Traveling Salesman Problem, the Vehicle Routing Problem, the Chinese Postman Problem, and the Rural Postman Problem. References are presented alphabetically under a number of subheadings.

Keywords: Bibliography, traveling salesman, vehicle routing, Chinese postman, rural postman, node routing, arc routing.

1. Introduction

Modern logistics is described by Christopher [103] as "the process of strategically managing the movement or storage of materials, parts and finished, inventory from suppliers, through the firm and on to the consumers". The efficient movement of goods or workers in order to increase and meet market demands is often emphasized in the business strategy of companies. It is estimated that distribution costs account for approximately 10% of the firms' revenues (LaLonde and Zinszer [274]) and to more than 45% of the total logistics costs (Institute of Logistics and Distribution Management [242]). In some cases, like in the soft drink industry, they represent approximately 70% of the value added costs of goods (Golden and Wasil [219]). The potential for savings is therefore considerable. Several successful implementations of computerized routing software have been documented in the literature. These successes can be attributed in part to algorithmic advances in the field of vehicle routing and also to the development of new software and computer technologies. Vehicle routing is truly one of the great success stories of operations research.

Researchers, particularly newcomers to the field, often have difficulty finding their way through the abundant and somewhat disorganized literature on vehicle routing. The purpose of this paper is to draw up a list of *some* of the main bibliographic references on the subject, within a simple and relatively broad classification scheme. As it is impractical and also rather unhelpful to provide an exhaustive bibliography, we have concentrated on those publications we consider the most useful or significant, namely references of general or historical nature, classical articles, and more recent work describing potentially significant developments. Interested readers should be able to fill some of the gaps by consulting the quoted survey articles.

We now introduce some basic notation common to all problems covered by this bibliography. Additional notation will be defined for each case. Let $G = (V, E \cup A)$ be a graph where $V = \{v_1, \ldots, v_n\}$ is a vertex set, $A = \{(v_i, v_j) : i \neq j,\ v_i, v_j \in V\}$ is a set of directed *arcs*, and $E = \{(v_i, v_j) : i < j,\ v_i, v_j \in V\}$ is a set of undirected *edges*. In most problems, either A or E is empty. Problems containing only arcs are said to be *directed* or *asymmetrical*; problems containing only edges are *undirected* or *symmetrical*. Problems containing a combination of arcs and edges are *mixed*. With each arc or edge (v_i, v_j) is associated a cost or distance c_{ij}. Various problems can be defined on G by specifying an objective and a set of constraints. Each problem exists in its *deterministic* or its *stochastic* form. In the latter case, some of the problem data are random variables. Such problems call for a different solution concept and a different solution methodology (see, e.g., Laporte and Louveaux [287]).

The following bibliography covers four classical routing problems, presented in sections 2 to 5: The Traveling Salesman Problem, the Vehicle Routing Problem, the Chinese Postman Problem, the Rural Postman Problem. In each section, references are presented alphabetically under a number of subheadings.

2. The Traveling Salesman Problem (TSP)

The TSP is defined on a graph $G = (V, A)$ or $G = (V, E)$ and consists of determining a shortest Hamiltonian circuit or cycle in G, depending on whether G is directed or not. This is probably the most studied problem in combinatorial optimization. Its origins are somewhat obscure. According to Müller-Merbach [346], it is stated in a 1831 paper by Voigt [487], but the first mention of the expression "Traveling Salesman Problem" is found in Menger [333]. The first major algorithmic study of the problem is that of Dantzig, Fulkerson and Johnson [114]. An interesting history of the TSP is provided in Hoffman and Wolfe [239]. The TSP is NP-hard [192] and its study has given rise to several theoretical and algorithmic results, some having far reaching effects in other areas of combinatorial optimization. Polyhedral theory [222, 367] is probably the most significant of these and has led to the development of powerful exact algorithms. Recently, new families of fast heuristic algorithms have been proposed, making use of sophisticated data structures, restricted neighbourhoods and constructive schemes combined with local reoptimization [198, 252]. The book by Lawler, Lenstra, Rinnooy Kan and Shmoys [303] contains an account of the main results on the TSP until 1985. For a more recent survey, see Laporte [283].

Several variants of the TSP have been defined. We only describe the most common cases. In the TSP with Time Windows, V contains a depot and each remaining vertex v_i must be visited within a time window $[a_i, b_i]$. In the Generalized TSP, V is a union of *clusters* $V_1, \ldots, V_k$ and the problem is to determine a Hamiltonian tour passing through each cluster exactly once or at least once. In the Clustered TSP, V contains a depot and the remaining vertices are partitioned into clusters. A precedence relation $<$ is defined on the partition. The problem consists of determining a least cost tour on G starting and ending at the depot, and such that if $V_p < V_q$, then all vertices of V_p are visited before those of V_q. Other variants of the TSP are obtained by associating a profit p_i with each vertex v_i. In the Selective TSP, one seeks a tour of maximal profit through a subset of V having a length not exceeding a preset bound. The Prize Collecting TSP is the reverse problem: here one must determine a least cost tour through a subset of V having a profit at least equal to a given lower bound.

2.1. GENERAL AND SURVEY WORK

Arthur and Frendewey [14], Freedman and Johnson, Geoch and Ostreimer [189], Hoffman and Wolfe [239], Laporte [282], Lawler, Lenstra, Rinnooy Kan and Shmoys [303], Menger [333], Müller-Merbach [346], Reinelt [406], Voigt [487].

2.2. APPLICATIONS

Bland and Shallcross [55], Eiselt and Laporte [156].

2.3. FORMULATIONS AND EXACT ALGORITHMS FOR THE ASYMMETRICAL TSP

Carpaneto, Fischetti and Toth [83], Desrochers and Laporte [122], Finke, Claus and Gunn [168], Fischetti and Toth [171], Langevin, Soumis and Desrosiers [279], Miller and Pekny [336], Padberg and Sung [371], Pekny and Miller [384], Wong [494].

2.4. FORMULATIONS AND EXACT ALGORITHMS FOR THE SYMMETRICAL TSP

Cornuéjols, Fonlupt and Naddef [108], Fischetti, Gonzalez and Toth [169], Fleischmann [181], Grötschel and Holland [221], Grötschel and Padberg [222], Land [277], Laporte [280], Martin [329], Naddef and Rinaldi [348], Padberg and Grötschel [367], Padberg and Rinaldi [368,369,370], Padberg and Sung [371].

2.5. HEURISTICS FOR THE TSP

Bartholdi and Platzman [29,30], Bentley [45], Bonomi and Lutton [64], Braun [71], Carlier and Villon [81], Codenotti and Margara [104], Fiechter [167], Gendreau, Hertz and Laporte [198], Glover [208], Gu and Huang [225], Jeong and Kim [251], Johnson [252], Jünger, Reinelt and Thienel [254], Kinderwater and Savelsbergh

[261], Knox [262, 263], Lee and Choi [304], Mak and Morton [323], Malek [325], Malek, Guruswamy, Owens and Panday [326], Margot [328], Martin, Otto and Felten [330], Ong and Huang [360], Papadimitriou [374], Potvin [388,389], Reinelt [405], Renaud, Boctor and Laporte [407], Rossier, Troyon and Liebling [418], Schnetzler [439], Sun, Meakin and Jossang [462], Ulder, Aarts, Bandelt, van Laarhoven and Pesch [479].

2.6. THE TSP WITH TIME WINDOWS

Baker [20], Daganzo [112], Desrosiers, Sauvé and Soumis [130], Dumas, Desrosiers, Gélinas and Solomon [145], Gendreau, Laporte and Solomon [204], Kubo and Kasugai [271], Tsitsiklis [477].

2.7. GENERALIZED AND CLUSTERED TSPs, TSPs WITH PRECEDENCE CONSTRAINTS

Bianco, Mingozzi, Ricciardelli and Spadoni [51], Gendreau, Hertz and Laporte [200], Kubo and Kasugai [271], Laporte and Nobert [296], Noon and Bean [354, 355].

2.8. SELECTIVE AND PRIZE COLLECTING TSPs

Balas [23], Fischetti and Toth [172], Golden, Levy and Vohra [216], Golden, Wang and Liu [218], Keller [258], Laporte and Martello [291], Laporte, Mercure and Nobert [292], Leifer and Rosenwein [305], Mittenthal and Noon [343], Ramesh and Brown [403], Ramesh, Yong-Seok and Karwan [404], Tsiligirides [476].

2.9. OTHER VARIANTS OF DETERMINISTIC TSPs

Bianco, Mingozzi and Ricciardelli [52], Cornuéjols, Fonlupt and Naddef [107], Fischetti, Laporte and Martello [170], Gavish and Srikanth [195], Lucena [316], Potvin, Lapalme and Rousseau [394], Russell [423], Semet and Lowenton [441].

2.10. STOCHASTIC TSPs

Bertsimas, Jaillet, and Odoni [47], Jaillet [247, 248] Laporte, Louveaux and Mercure [290].

3. The vehicle routing problem (VRP)

The "classical VRP" is also defined on a graph $G = (V, A \cup E)$. Vertex v_1 is a depot at which are based identical vehicles of capacity Q. The remaining vertices represent customers. The problem is then to determine a set of least cost vehicle routes starting and ending at the depot, such that each vertex of $V \setminus \{v_1\}$ is visited exactly once, and satisfying a number of side constraints. Here are the most common of these restrictions. (i) Capacity constraints: with each vertex v_i is associated a non-negative demand q_i and the sum of demands in each route may not exceed Q; (ii) Time constraints: here, a travel time t_{ij} is associated with each arc or edge and each city of $V \backslash \{v_1\}$ has a non-negative service time δ_i; the total duration of each route must not exceed a preset bound L; (iii) Time windows: all vehicles leave the depot at time 0 and customer v_i must be visited within a time window $[a_i, b_i]$.

The VRP plays a central role in distribution management and has for a long time attracted the attention of operations researchers. It was described as the *Truck Dispatching Problem* in an early paper by Dantzig and Ramser [115], but the designation VRP is now more common. The problem is still largely unsolved. Exact methods are rarely applicable to problems in excess of 50 vertices [284, 295]. Integer linear programming approaches based on constraint relaxation work relatively well on loosely constrainted problems [297, 299], while column generation algorithms are better suited for tightly constrained problems [121, 131]. Recently, there has been a surge in the development of local search heuristics for the VRP [201]. For recent surveys of VRP algorithms, see Fisher [176], Laporte [284], and Osman [364]. Time constrained VRPs and vehicle scheduling problems are reviewed in Desrosiers, Dumas, Solomon and Soumis [126].

A wide number of variants to the basic problem exist (see, e.g., Assad [15]), such as multiple depots, heterogeneous vehicles, precedence constraints between customers (including the VRP with backhauls), combined pickup and deliveries (including dial-a-ride problems), multiple visits, split deliveries, full load deliveries, multiple-period routing, etc. In the Fleet Size and Mix VRP, the aim is to determine a least cost vehicle fleet to fit the demand. Location-Routing problems investigate the joint effect of locational and routing decisions. A problem closely related to the VRP is the Vehicle Scheduling Problem: here the problem is to design vehicle schedules so as to optimally cover a set of preset routes, tasks or requests. Although these restrictions and variants are often important in practice, they have not received as much attention as the basic problem.

3.1. GENERAL AND SURVEY WORK

Achuthan and Caccetta [1], Assad [15], Beasley [33], Bodin [56], Bodin and Golden [58], Bodin, Golden, Assad and Ball [59], Bookbinder and Reece [65], Bott and Ballou [67], Christofides [92], Christofides and Mingozzi [99], Christofides, Mingozzi and Toth [101], Christopher [104], Current and Marsh [110], Dantzig and Ramser [115], Dejax [117], Desrochers, Lenstra and Savelsbergh [123], Desrosiers, Dumas, Solomon and Soumis [126], Eilon, Watson-Gandy and Christofides [152], Fisher [176], Golden and Assad [210, 211], Hall [233], Institute of Logistics and Distribution Management [242], Laporte [282, 284], Lenstra and Rinnooy Kan [307], Osman [364], Osman and Laporte [365], Ronen [417].

3.2. APPLICATIONS AND SOFTWARE

Bechara and Galvao [37], Belardo, Duchessi and Seagle [38], Bodin and Salamone [62], Brown, Ellis, Graves and Ronen [74], Brown and Graves [75], Duchessi, Belardo and Seagle [144], Evans and Norback [162], Golden, Bodin and Goodwin [214], Golden and Wasil [219], Holt and Watts [240], Kim [260], Lukka [318], Lysgaard [320], Mathews and Waters [331], O'Neil and Bommer [358], Pape [375], Pooley [386], Potvin, Lapalme and Rousseau [393], Raghavendra, Krishnakumar, Muralidhar, Sarvanan and Raghavendra [401], Robuste, Daganzo and Souleyrette [415], Russell and Chalinor [424], Sateesh and Ray [433], Savelsbergh [436], Semet and Taillard [442], Sena [443], Solomon, Chalifour, Desrosiers and Boisvert [453], Sørensen [455], Sutcliffe and Board [463], Taylor [467], van Vliet, Boender, Guus and Rinnooy Kan [485], Waters [489, 490], Yano, Chan, Ritcher, Cutler, Murity and McGettigan [498], Zielinski [500].

3.3. FORMULATIONS AND EXACT ALGORITHMS FOR THE CLASSICAL VRP WITHOUT TIME WINDOWS

Agarwal, Mathur and Salkin [3], Araque, Kudva, Morin and Pekny [13], Brodie and Waters [73], Campos, Corberán and Mota [80], Christofides, Hadjiconstantinou and Mingozzi [98], Christofides, Mingozzi and Toth [100, 102], Cornuéjols and Harche [108], Desrochers and Laporte [122], Fischetti, Toth and Vigo [173], Fisher [174, 175], Fleuren [184], Gavish and Graves [194], Jansen [249], Kulkarni and Bhave [272], Laporte, Mercure and Nobert [293, 294], Laporte and Nobert [295, 297], Laporte, Nobert and Desrochers [299], Laporte, Nobert and Taillefer [300, 301], Li, Simchi-Levi and Desrochers [312], Lucena [317], Miller [335], Mingozzi, Christofides and Hadjiconstantinou [340], Naddef [347].

3.4. HEURISTIC ALGORITHMS FOR THE CLASSICAL VRP WITHOUT TIME WINDOWS

Alfa, Heragu and Chen [5], Altinkemer and Gavish [8, 9, 10], Baker [19], Ballou [25], Ballou and Agarwal [26], Beasley [34], Beasley and Christofides [35], Bienstock, Bramel and Simchi-Levi [54], Bowerman, Calamai and Hall [66], Bramel, Coffman, Shor and Simchi-Levi [68], Buxey [78, 79], Christofides, Mingozzi and Toth [101], Cullen, Jarvis and Ratliff [109], El Ghaziri [157], Fahrin and Wrede [163], Fisher and Jaikumar [177], Foisy and Potvin [185], Gendreau, Hertz and Laporte [199], Gendreau, Laporte and Potvin [201], Golden and Skiscim [217], Haimovich and Rinnooy Kan [230], Haimovich, Rinnooy Kan and Stougie [231], Halse [234], Hiquebran, Alfa and Shapiro [232], Kadaba, Nygard and Juell [255], Kagaya, Kicuchi and Donnelly [256], Kinderwater and Savelsbergh [261], Kopfer, Pankratz and Erkens [266], Li, Simchi-Levi and Desrochers [312], Lukka [318], Macleod and Moll [321], Mole, Johnson and Wells [345], Nelson, Nygard, Griffin and Shreve [352], Nygard and Juell [357], Osman [362, 363], Paessens [372], Park and Koelling [376], Potvin [387], Potvin, Lapalme and Rousseau [392, 393, 394], Pureza and Franca [400], Renaud, Boctor and Laporte [408], Ryan, Hjorring and Glover [427], Salhi and Rand [428], Savelsbergh [435], Semet and Taillard [442], Sørensen [455], Stewart and Golden [459], Taillard [465], Thompson [473], Thompson and Psaraftis [474], Van Breedam [482], Vigo [486], Wark and Holt [488], Willard[491], Wong and Beasley [495], Woolsey [496], Zanakis, Evans and Vazacopoulos [499].

3.5. THE VRP WITH TIME WINDOWS

Ahn and Shin [4], Atkinson [18], Baker and Schaffer [21], Bramel, Li and Simchi-Levi [69], Bramel and Simchi-Levi [70], Chiang and Russell [90], Derigs and Grabenbauer [120], Desrochers, Desrosiers and Solomon[121], Desrochers, Lenstra, Savelsberg and Soumis [124], Desrosiers, Sauvé and Soumis [130], Desrosiers, Soumis and Desrochers [131], Desrosiers, Soumis, Desrochers and Sauvé [132], Dumas, Desrosiers and Soumis [146], Ferland and Fortin [165], Fisher [175], Fisher, Jörnsten and Madsen [179], Garcia, Potvin and Rousseau [191], Haouari, Dejax and Desrochers [236], Jörnsten, Madsen and Sørensen [253], Kolen, Rinnooy Kan and Trienekens [264], Kontoradis and Bard [265], Koskosidis and Powell [268], Koskosidis, Powell and Solomon [269], Langevin and Soumis [278], Min [338], Nygard, Greenberg, Bolkan and Swenson [356], Potvin, Dubé and Robillard [390], Potvin, Kervahut and Rousseau [391], Potvin and Rousseau [395], Psaraftis, Solomon, Magnanti and Kim [399], Russell [422], Savelsberg [434, 437], Sexton and Choi [446], Sol and Savelsbergh [449], Solomon [450, 451], Solomon, Baker and Schaffer [452], Solomon and Desrosiers [454], Thangiah [468], Thangiah, Nygard and Juell [469], Thangiah, Osman, Vinayagamoorthy and Sun [470], Thangiah, Sun and Potvin [472], Van der Bruggen, Lenstra and Shuur [483], van Landeghem [484].

3.6. VRPs WITH PRECEDENCE RELATIONS

Desrosiers, Dumas and Soumis [127], Gélinas, Desrochers, Desrosiers and Solomon [197], Goetschalckx and Jacobs-Blecha [209], Jacobs-Blecha and Goetschalckx [246], Min, Current and Schilling [339], Toth and Vigo [475].

3.7. VRPs WITH COMBINED PICKUP AND DELIVERIES

Casco, Golden and Wasil [84], Daganzo and Hall [113], Deif and Bodin [116], Derigs and Metz [119], Dumas, Desrosiers and Soumis [146], Fisher, Jiegang and Bao-Xing [178], Fisher, Tang and Zhen [180], Min [337], Savelsbergh and Sol [438], Sexton and Choi [446], Sol and Savelsbergh [449], Thangiah, Sun and Potvin [472], Van der Bruggen, Lenstra and Shuur [483].

3.8. MULTI-PERIOD VRPs

Christofides and Beasley [94], Gaudioso and Paletta [193], Russell and Gribbin [425], Tan and Beasley [466].

3.9. MULTI-DEPOT VRPs

Bianco, Mingozzi and Ricciardelli [53], Carpaneto, Dell'Amico, Fischetti and Toth [82], Chao, Golden and Wasil [86], Dell'Amico, Fischetti and Toth [118], Laporte, Nobert and Taillefer [300], Li and Simchi-Levi [311], Mesquita and Paixo [334], Renaud, Laporte and Boctor [409].

3.10. FLEET SIZE AND MIX PROBLEMS

Beaujon and Turnquist [36], Buxey [78], Desrochers and Verhoog [125], Desrosiers, Sauvé and Soumis [130], Etazadi and Beasley [158], Ferland and Michelon [116], Gheysens, Golden and Assad [206,207], Golden, Assad, Levy and Gheysens [213], Larson, Minkoff and Gregory [302], Mole [344], Osman and Salhi [366], Parikh [377], Ronen [416], Salhi and Rand [430], Salhi, Sari and Sadi [431].

3.11. LOCATION-ROUTING PROBLEMS

Balakrishnan, Ward and Wong [22], Eiselt and Laporte [155], Hansen, Hegedahl, Hjortkjaer and Obel [235], Laporte [281], Laporte and Dejax [285], Laporte, Louveaux and Mercure [289], Laporte, Nobert and Arpin [298], Laporte, Nobert and Taillefer [300], Madsen [322], Nambiar, Gelders and van Wassenhove [350], Salhi and Rand [429], Srivastava [456], Srivastava and Benton [457].

3.12. DIAL-A-RIDE AND VEHICLE SCHEDULING PROBLEMS

Ballou [25], Ballou and Agarwal [26], Bodin and Sexton [63], Cyrus[111], Dell'Amico, Fischetti and Toth [118], Desrosiers, Dumas, Solomon and Soumis [126], Desrosiers, Dumas and Soumis [127], Desrosiers, Dumas and Soumis [128], Dumas, Desrosiers and Soumis [147], Hooker and Natraj [241], Ioachim, Desrosiers, Dumas and Solomon [243], Jaw, Odoni, Psaraftis and Wilson [250], Kim [260], Koskosidis and Powell [268], Koskosidis, Powell and Solomon [269], Kubo and Kasugai [270], Nygard and Juell [357], Psaraftis [396,398], Psaraftis, Solomon, Magnanti and Kim [399], Ribeiro and Soumis [410], Roy, Rousseau, Lapalme and Ferland [420,421], Sexton and Bodin [444,445], Skitt and Levary [448], Solomon [450,451], Solomon, Baker and Schaffer [452], Solomon and Desrosiers [454], Swersey and Ballard [464], Thompson and Psaraftis [474].

3.13. OTHER VARIANTS OF DETERMINISTIC VRPs

Afrati, Cosmadakis, Papadimitriou, Papageorgiou and Papakostantinou [2], Anily and Federgruen [11, 12], Brenninger-Göthe [72], Busch [77], Chien, Balakrishnan and Wong [91], Desrosiers, Laporte, Sauvé, Soumis and Taillefer [129], Dror and Ball [134], Dror, Ball and Golden [135], Dror, Laporte and Trudeau [137], Dror and Levy [139], Dror and Trudeau [142, 143], Federgruen and Zipkin [164], Ferland and Michelon [166], França, Gendreau, Laporte and Müller [186], Frizzell and Giffin [190], Golden, Assad and Dahl [212], Labbé, Laporte and Mercure [373], Lamatsch [275], Malandraki and Daskin [324], Min [373], Nag [349], Pooley [385], Psaraftis [397], Russell and Igo [426], Thangiah, Osman,Vinayagamoorthy and Sun [471].

3.14. STOCHASTIC VRPs

Bastian and Rinnooy Kan [31], Beasley [32], Bertsimas [46], Bertsimas, Jaillet, and Odoni [39], Bertsimas and Van Ryzin [48, 49, 50], Bienstock, Bramel and Simchi-Levi [54], Dror [133], Dror, Laporte and Louveaux [136], Dror, Laporte and Trudeau [137], Dror and Trudeau[141], Gendreau, Laporte and Séguin [202, 203], Lambert, Laporteand Louveaux [276], Laporte and Louveaux [286], Laporte, Louveaux and Mercure [288, 289], Séguin [440], Simchi-Levi [447], Stewart and Golden [460].

4. The Chinese Postman Problem (CPP)

Both the TSP and the VRP are *vertex routing problems* as they impose that each vertex be visited. In some contexts such as snow plowing or garbage collection, it is required to cover all *arcs* of G. Such problems are called *arc routing problems*. The unconstrained case is the *Chinese Postman Problem* (CPP). The CPP can be defined on an undirected graph, on a directed graph, or on a mixed graph. The Windy Postman Problem (WPP) is defined on an undirected graph, but the cost of traversing an edge depends on the direction of travel. In the Hierarchical CPP, V contains a source s and a sink t. The arcs of A not incident to s or t are partitioned into $\{A_1, \ldots, A_k\}$, and an order relation $\prec$ is imposed on the elements of the partition. The problem is to determine a least cost traversal of G starting at s, ending at t, and *servicing* the arcs of the partition in such a way that if $A_p \prec A_q$, then all arcs of A_p are serviced before any arc of A_q. However, arcs of A_q may be serviced before some arcs of A_p.

The origins of the CPP can be traced back to the work of Euler [159, 160], who sought to determine whether there existed a closed walk traversing each of the seven Königsberg bridges exactly once. Such a walk is called an Eulerian tour. Hierholzer [238] addressed the question of determining a closed walk when one exists, while Meigu Guan (or Kwan Mei-Ko) [226] investigated the problem of determining the shortest traversal of a connected graph known to contain no Eulerian tour. Both the pure undirected and directed versions of the CPP can be solved in polynomial time, but the mixed case, the Windy CPP, and several variants of the basic CPP are NP-hard. The complexity of the Hierarchical CPP depends on the structure of G and on whether the order relation is complete or not. Recent surveys of Eulerian graphs and of the CPP are provided in Fleischner [182, 183] and in Eiselt, Gendreau and Laporte [153].

4.1. GENERAL AND SURVEY WORK

Assad and Golden [16], Bodin and Levy [60], Christofides [93], Edmonds and Johnson [148], Eiselt, Gendreau and Laporte [153], Evans and Minieka [161], Fleischner [182, 183], Guan [228], Liebling [314], Orloff [361], Papadimitriou [373], Pearn, Assad and Golden [382], Su [461], Win [492].

4.2. APPLICATIONS

Assad and Golden [16], Barahona [27, 28], Bodin, Fagin, Welebny and Greenberg [57], Cebry, De Silva and Disilio [85], Eglese and Murdock[151], Malek, Mourad and Pandya [327], Riccio [411], Riccio and Litke [412], Roy and Rousseau [419].

4.3. THE UNDIRECTED CPP

Edmonds and Johnson [148], Euler [159, 160], Guan [277], Hierholzer [238], Itai, Lipton, Papadimitriou and Rodeh [244], Itai and Rodeh [245], Kesel'man [259], Korach and Penn [267].

4.4. THE DIRECTED CPP

Beltrami and Bodin [41], Edmonds and Johnson [148], Guan and Pulleyblank [229], Lin and Zhao [315], Richey and Parker [413], Richey, Parker and Rardin [414], van Aardenne-Ehrenfest and de Bruijn [481].

4.5. THE MIXED CPP

Brucker [76], Christofides, Benavent, Campos, Corberán and Mota [95], Edmonds and Johnson [148], Kappauf and Koehler [257], Minieka [341], Nobert and Picard [353], Ralphs [402], Win [492].

4.6. THE WINDY CPP

Gendreau, Laporte and Zhao [205], Grötschel and Win [223, 224], Guan [227], Pearn and Li [383], Win [492, 493].

4.7. THE HIERARCHICAL CPP

Alfa and Liu [6], Dror, Stern and Trudeau [140], Gélinas [196].

4.8. OTHER VARIANTS OF THE CPP

Dror, Stern and Trudeau [140], Malandraki and Daskin [324].

5. The Rural Postman Problem (RPP)

In some arc routing problems, only a subset R of the arcs or of the edges have to be visited. Such problems are referred to as Rural Postman Problems and can be viewed as a special case of the Capacitated Arc Routing Problem (CARP) defined as follows. In G, each arc or edge (v_i, v_j) has a non-negative weight q_{ij}. One must service in a least cost fashion all arcs or edges with $q_{ij} > 0$, using identical vehicles of capacity Q, in such a way that the sum of weights on the arcs serviced by the same vehicle does not exceed Q. The classical RPP is obtained by setting $R = \{(v_i, v_j) \in A \cup E : q_{ij} > 0\}$ and $Q = \infty$. The Stacker Crane Problem is defined on a mixed graph and consists of traversing all directed arcs in a least cost fashion. Several other variants of these basic arc routing problems have also been investigated. Common applications of RPPs are mail delivery, snow plowing, garbage collection, meter reading, milk delivery, parking meter collection, school bus routing, etc. For a recent survey of these applications and of RPP algorithms, see Eiselt, Gendreau and Laporte [154].

5.1. GENERAL AND SURVEY WORK

Benavent, Campos, Corberán and Mota [42], Christofides [93], Eiselt, Gendreau and Laporte [154].

5.2. APPLICATIONS

Alprin [7], Ball and Magazine [24], Bodin, Fagin, Welebny and Greenberg [57], Bodin and Levy [61], Chen, Kallsen, Chen and Tseng [89], Eglese [149], Eglese and Li [150], Eglese and Murdock [151], Haslam and Wright [237], Lemieux and Campagna [306], Levy [308], Levy and Bodin [309,310], Li [313], McBride [332], Minnazzato [342], Negreiros [351], Ong, Goh, Poh and Lim [359], Roy and Rousseau [419], Stern and Dror [458], Tucker and Clohan [478], Wunderlich, Collette, Levy and Bodin [497].

5.3. THE UNDIRECTED RPP

Christofides, Campos, Corberán and Mota [96], Corberán and Sanchis [105, 106], Frederickson [187], Sanchis [432].

5.4. THE DIRECTED RPP

Christofides, Campos, Corberán and Mota [97].

5.5. THE STACKER CRANE PROBLEM

Christofides, Campos, Corberán and Mota [97], Frederickson, Hecht and Kim [188], Lukka and Salminen [319].

5.6. THE CAPACITATED ARC ROUTING PROBLEM

Assad, Pearn and Golden [17], Belenguer [39], Belenguer and Benavent [40], Benavent, Campos, Corberán and Mota [43,44], Chapleau, Ferland, Lapalme and Rousseau [87,88], Golden, DeArmon and Baker [215], Golden and Wong [270], Pearn [378,379,380,381], Pearn, Assad and Golden [382], Ulusoy [480], Win [492].

References

[1] N.R. Achuthan and L. Caccetta, Integer linear programming formulation for a vehicle routing problem, European Journal of Operational Research 52(1991)86.
[2] F. Afrati, S. Cosmadakis, C. Papadimitriou, G. Papageorgiou and N. Papakostantinou, The complexity of the traveling repairman problem, Theoretical Informatics and Applications 20(1986)79.
[3] Y. Agarwal, K. Mathur and H.M. Salkin, A set-partitioning-based algorithm for the vehicle routing problem, Networks 19(1989)731.
[4] B.H. Ahn and L. Shin, Vehicle routing with time windows and time varying congestions, Journal of the Operational Research Society 42(1991)393.
[5] A.S. Alfa, S.S. Heragu and M. Chen, A 3-opt based simulated annealing algorithm for the vehicle routing problem, Computers and Industrial Engineering 21(1991)635.
[6] A.S. Alfa and D.Q. Liu, Postman routing problem in a hierarchical network, Engineering Optimisation 14(1988)127.
[7] B.S. Alprin, A simulation approach to solving the snow and ice removal problem in an urban area, M.Sc. Dissertation, The University of Tulsa, OK (1975).
[8] K. Altinkemer and B. Gavish, Heuristics for unequal weight delivery problems with a fixed error guarantee, Operations Research Letters 6(1987)149.
[9] K. Altinkemer and B. Gavish, Heuristics for delivery problems with constant error guarantees, Transportation Science 24(1990)294.
[10] K. Altinkemer and B. Gavish, Parallel savings based heuristics for the delivery problem, Operations Research 39(1991)456.
[11] S. Anily and A. Federgruen, Two-echelon distribution systems with vehicle routing costs and central inventories, Operations Research 41(1993)37.
[12] S. Anily and A. Federgruen, A class of Euclidean routing problems with general route cost functions, Mathematics of Operations Research 15(1990)268.
[13] J.R. Araque, G. Kudva, T.L. Morin and J.F. Pekny, A branch-and-cut algorithm for vehicle routing problems, Annals of Operations Research 50(1994)37.

[14] J.L. Arthur and J.O. Frendewey, Generating travelling-salesman problems with known optimal tours, Journal of the Operational Research Society 39(1988)153.

[15] A.A. Assad, Modeling and implementation issues, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).

[16] A.A. Assad and B.L. Golden, Arc routing methods and applications, *Handbook of Operations Research and Management Science: Networks and Distribution*, Volume 8, eds. M. Ball, T. Magnanti, C. Monma and G. Nemhauser (North-Holland, Amsterdam, 1995).

[17] A.A. Assad, W.-L. Pearn and B.L. Golden, The capacitated Chinese postman problem: Lower bounds and solvable cases, American Journal of Mathematical and Management Sciences 7(1987)63.

[18] J.B. Atkinson, A greedy, look-ahead heuristic for combinatorial optimization: An application to vehicle scheduling with time windows, Journal of the Operational Research Society 45(1994)673.

[19] B.M. Baker, Further improvements to vehicle routing heuristics, Journal of the Operational Research Society 43(1992)1009.

[20] E. Baker, An exact algorithm for the time constrained traveling salesman problem, Operations Research 31(1983)938.

[21] E. Baker and J. Schaffer, Computational experience with branch exchange heuristics for vehicle routing problem with time window constraints, American Journal of Mathematical and Management Sciences 6(1986)261.

[22] A. Balakrishnan, J.E. Ward and R.T. Wong, Integrated facility location and vehicle routing models: Recent work and future prospects, American Journal of Mathematical and Management Sciences 7(1987)35.

[23] E. Balas, The prize collecting traveling salesman problem, Networks 19(1989)621.

[24] M.O. Ball and M.J. Magazine, Sequencing of insertions in printed circuit board assembly, Operations Research 36(1988)192.

[25] R.H. Ballou, A continued comparison of several popular algorithms for vehicle routing and scheduling, Journal of Business Logistics 11(1990)111.

[26] R.H. Ballou and Y.K. Agarwal, A performance comparison of several popular algorithms for vehicle routing and scheduling, Journal of Business Logistics 11(1988)51.

[27] F. Barahona, On some applications of the Chinese postman problem, in: *Combinatorics & Optimization*, Research Report CORR 8855, Faculty of Mathematics, University of Waterloo (1988).

[28] F. Barahona, On via minimization, in: *Combinatorics & Optimization*, Research Report CORR 8810, Faculty of Mathematics, University of Waterloo (1988).

[29] B. Bartholdi and L.K. Platzman, Heuristics based on space-filling curves for combinatorial optimizations in Euclidean space, Management Science 34(1988)291.

[30] B. Bartholdi and L.K. Platzman, On $O(N \log N)$ planar travelling salesman heuristic based on space-filling curves, Operations Research Letters 1(1982)121.

[31] C. Bastian and A.H.G. Rinnooy Kan, The stochastic vehicle routing problem revisited, European Journal of Operational Research 56(1992)407.

[32] J.E. Beasley, Fixed routes, Journal of the Operational Research Society 35(1984)49.

[33] J.E. Beasley, OR-library: Distribution test problems by electronic mail, Journal of the Operational Research Society 41(1990)1069.

[34] J.E. Beasley, Route first-cluster second methods for vehicle routing, Omega 11(1983)403.

[35] J.E. Beasley and N. Christofides, Vehicle routing with a sparse feasibility graph, Working Paper, The Management School, Imperial College, U.K. (1994).

[36] G.L. Beaujon and M.A. Turnquist, A model for the fleet sizing and vehicle allocation, Transportation Science 25(1991)19.
[37] J.J.B. Bechara and R.D. Galvão, The use of interactive computing for vehicle routing, Lecture Notes in Control and Information Sciences 87(1987)22.
[38] S.P. Belardo, P. Duchessi and J. Seagle, Micro-computer graphics in support of vehicle fleet routing, Interfaces 15(6) (1985) 84.
[39] J.M. Belenguer, El poliedro del problema de rutas por arcos con capacidades, Ph.D. Thesis, Universidad de Valencia (1990).
[40] J.M. Belenguer and E. Benavent, Polyhedral results on the capacitated arc routing problem, Working Paper, Universidad de Valencia (1992).
[41] E.L. Beltrami and L.D. Bodin, Networks and vehicle routing for municipal waste collection, Networks 4(1974)65.
[42] E. Benavent, V. Campos, A. Corberán and E. Mota, Problemas de rutas por arcos, Quaderns d'Estadística, Sistemas, Informàtica i Investigació Operativa (QÜESTIIÓ) 7 (1983)479.
[43] E. Benavent, V. Campos, A. Corberán and E. Mota, The capacitated arc routing problem: Lower bounds, Networks 22(1992)669.
[44] E. Benavent, V. Campos, A. Corberán and E. Mota, The capacitated arc routing problem. A heuristic algorithm, Quaderns d'Estadística, Sistemas, Informática i Investigació Operativa (QÜESTIIÓ) 14(1990)107.
[45] J.J. Bentley, Fast algorithms for geometric traveling salesman problems, ORSA Journal on Computing 4(1992)387.
[46] D.J. Bertsimas, A vehicle routing problem with stochastic demand, Operations Research 40(1992)574.
[47] D.J. Bertsimas, P. Jaillet, and A.R. Odoni, A priori optimization, Operations Research 38(1990)1019.
[48] D.J. Bertsimas and G. van Ryzin, A stochastic and dynamic vehicle routing problem in the Euclidean plane, Operations Research 39(1991)601.
[49] D.J. Bertsimas and G. van Ryzin, Stochastic and dynamic vehicle routing in the Euclidean plane with multiple capacitated vehicles, Operations Research 41(1993)60.
[50] D.J. Bertsimas and G. van Ryzin, Stochastic and dynamic vehicle routing with general demand and interarrival time distributions, Advances in Applied Probability 25(1993)947.
[51] L. Bianco, A. Mingozzi, S. Ricciardelli and M. Spadoni, Exact and heuristic procedures for the travelling salesman problem with precedence constraints based on dynamic programming, INFOR 32(1994)19.
[52] L. Bianco, A. Mingozzi and S. Ricciardelli, The travelling salesman with cumulative costs, Networks 23(1993)81.
[53] L. Bianco, A. Mingozzi and S. Ricciardelli, A set partitionning approach to the multiple depot vehicle scheduling problem, Optimization Methods and Software 3(1994)163.
[54] D. Bienstock, J. Bramel and D. Simchi-Levi, A probabilistic analysis of tour partitioning heuristics for the capacitated vehicle routing problem with unsplit demands, Mathematics of Operations Research 18(1993)786.
[55] R.G. Bland and D.F. Shallcross, Large traveling salesman problems arising from experiments in X-ray crystallography: A preliminary report on computation, Operations Research Letters 8(1989)125.
[56] L.D. Bodin, Twenty years of routing and scheduling, Operations Research 38(1990)571.

[57] L.D. Bodin, G. Fagin, R. Welebny and J. Greenberg, The design of a computerized sanitation vehicle routing and scheduling system for the town of Oyster Bay, New York, Computers and Operations Research 16(1989)45.
[58] L.D. Bodin and B.L. Golden, Classification in vehicle routing and scheduling, Networks 11(1981)97.
[59] L.D. Bodin, B.L. Golden, A.A. Assad and M.O. Ball, Routing and scheduling of vehicles and crews. The state of the art, Computers and Operations Research 10(1983)69.
[60] L.D. Bodin and L.S. Levy, Visualization in routing and scheduling problems, ORSA Journal on Computing 6(1994)281.
[61] L.D. Bodin and L.S. Levy, The arc partitioning problem, European Journal of Operational Research 53(1991)393.
[62] L.D. Bodin and D.J. Salamone, The development of a microcomputer based system for vehicle routing and its use for solving spatial and temporal problems, Mathematical and Computer Modelling 11(1988)558.
[63] L.D. Bodin and T. Sexton, The multi-vehicle subscriber dial-a-ride problem, TIMS Studies in the Management Sciences 26(1986)73.
[64] E. Bonomi and J.-L. Lutton, The N-city travelling salesman problem: Statistical mechanics and the metropolis algorithm, SIAM Review 26(1984)551.
[65] J.H. Bookbinder and K.E. Reece, Vehicle routing considerations in distribution system design, European Journal of Operational Research 37(1988)204.
[66] R.L. Bowerman, P.H. Calamai and G.B. Hall, The spacefilling curve with optimal partitioning heuristic for the vehicle routing problem, European Journal of Operational Research 76 (1994)128.
[67] K. Bott and R. Ballou, Research perspectives in vehicle routing, Transportation Research A20(1986)239.
[68] J. Bramel, E.G. Coffman, P.W. Shor and D. Simchi-Levi, Probabilistic analysis of the capacitated vehicle routing problem with unsplit demands, Operations Research 40(1992)1095.
[69] J. Bramel, C.L. Li and D. Simchi-Levi, Probabilistic analysis of a vehicle routing problem with time windows, American Journal of Mathematical and Management Sciences 13(1993)267.
[70] J. Bramel and D. Simchi-Levi, Probabilistic analyses and practical algorithms for the vehicle routing problem with time windows, Working Paper, Graduate School of Business, Columbia University, New York (1993).
[71] H. Braun, On solving traveling salesman problems by genetic algorithms, Lecture Notes in Computer Science 496(1991)129.
[72] M. Brenninger-Göthe, Two vehicle routing problems – mathematical programming approaches, Dissertation 200, Linköping Studies in Science and Technology, Department of Mathematics, Linköping University, Sweden (1989).
[73] G.R. Brodie and C.D.J. Waters, Integer linear programming formulation for vehicle problems, European Journal of Operational Research 34(1988)403.
[74] G. Brown, C. Ellis, G. Graves and D. Ronen, Real-time wide area dispatch of mobil tank trucks, Interfaces 17(1) (1987) 107.
[75] G. Brown and G. Graves, Real-time dispatch of petroleum tank trucks, Management Science 27(1981)19.
[76] P. Brucker, The Chinese postman problem for mixed graphs, in: *Graph Theoretic Concepts in Computer Science*, ed. H. Noltemeir (Springer, Berlin, 1981).

[77] I.K. Busch, Vehicle routing on acyclic networks, Ph.D. Dissertation, The Johns Hopkins University (1991).
[78] G.M. Buxey, Designing routes to minimize fleet operating cost, European Journal of Operational Research 21(1985)57.
[79] G.M. Buxey, The vehicle scheduling problem and Monte-Carlo simulation, Journal of the Operational Research Society 30(1979)563.
[80] V. Campos, A. Corberán and E. Mota, Polyhedral results for a vehicle routing problem, European Journal of Operational Research 52(1991)75.
[81] J. Carlier and P. Villon, A new heuristic for the traveling salesman problem, RAIRO (Recherche opérationnelle) 24(1990)245.
[82] G. Carpaneto, M. Dell'Amico, M. Fischetti and P. Toth, A branch and bound algorithm for the multiple depot vehicle scheduling problem, Networks 19(1989)531.
[83[G. Carpaneto, M. Fischetti and P. Toth, New lower bounds for the symmetric travelling salesman, Mathematical Programming 45(1989)233.
[84] D.O. Casco, B.L. Golden and E.A. Wasil, Vehicle routing with backhauls: Models, algorithms and case studies, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[85] M.E. Cebry, A.H. DeSilva, and F.D. Dilisio, Management science in automating postal operations: Facility and equipment planning in the United States postal operations, Interfaces 22(1) (1992)110.
[86] M. Chao, B.L. Golden and E. Wasil, A new heuristic for the multi-depot vehicle routing problem that improves upon best-known solutions, American Journal of Mathematical and Management Sciences 13(1993)371.
[87] L. Chapleau, J.A. Ferland, G. Lapalme and J.-M. Rousseau, A parallel insert method for the capacitated arc routing problem, Operations Research Letters 3(1984)95.
[88] L. Chapleau, J.A. Ferland and J.-M. Rousseau, Clustering for routing in densely populated areas, European Journal of Operational Research 20(1985)48.
[89] D.S. Chen, H.A. Kallsen, H.C. Chen and V.C. Tseng, A bus routing system for rural school districts, Computers and Industrial Engineering 19(1990)322.
[90] W.C. Chiang and R.A. Russell, Simulated annealing metaheuristics for the vehicle routing problem with time windows, Annals of Operations Research (1996), forthcoming.
[91] T.W. Chien, A. Balakrishnan and R.T. Wong, An integrated inventory allocation and vehicle routing problem, Transportation Science 23(1989)67.
[92] N. Christofides, Vehicle routing, in: *The Travelling Salesman Problem: A Guided Tour of Combinatorial Optimization*, eds. E.L. Lawler, J.K. Lenstra, A.H.G. Rinnooy Kan and D. Shmoys (Wiley, 1985).
[93] N. Christofides, *Graph Theory. An Algorithmic Approach* (Academic Press, London, 1975).
[94] N. Christofides and J.E. Beasley, The period routing problem, Networks 14(1984)237.
[95] N. Christofides, E. Benavent, V. Campos, A. Corberán and E. Mota, An optimal method for the mixed postman problem, in: *System Modelling and Optimization*, Lecture Notes in Control and Information Sciences 59, ed. P. Thoft-Christensen (Springer, Berlin, 1984).
[96] N. Christofides, V. Campos, A. Corberán and E. Mota, An algorithm for the rural postman problem, Imperial College Report I.C.O.R.81.5 (1981).
[97] N. Christofides, V. Campos, A. Corberán and E. Mota, An algorithm for the rural postman problem on a directed graph, Mathematical Programming Study 26(1986)155.

[98] N. Christofides, E. Hadjiconstantinou and A. Mingozzi, A new exact algorithm for the vehicle routing problem based on q-path and k-shortest path relaxations, Working Paper, The Management School, Imperial College, London (1993).
[99] N. Christofides and A. Mingozzi, Vehicle routing: Practical and algorithmic aspects, in: *Logistics: Where the Ends Have to Meet*, ed. C.F.H. van Rijn (Pergamon, 1989).
[100] N. Christofides, A. Mingozzi and P. Toth, State space relaxation procedures for the computation of bounds to routing problems, Networks 11(1981)145.
[101] N. Christofides, A. Mingozzi and P. Toth, The vehicle routing problem, in: *Combinatorial Optimization*, eds. N. Christofides, N. Mingozzi, A.Toth and C. Sandi (Wiley, Chichester, 1979).
[102] N. Christofides, A. Mingozzi and P. Toth, Exact algorithms for the vehicle routing problem, based on spanning tree and shortest path relaxations, Mathematical Programming 20(1981)255.
[103] M. Christopher, *The Strategy of Distribution Management* (Gower, 1985).
[104] B. Codenotti and L. Margara, Traveling salesman prolem and local search, Applied Mathematics Letters 5(1992)69.
[105] A. Corberán and J.M. Sanchis, A polyhedral approach to the rural postman problem, European Journal of Operational Research 79(1994)95.
[106] A. Corberán and J.M. Sanchis, On the general routing problem polyhedron: Facets from the GTSP and RPP polyhedra, Working Paper, Departamento de Estadística e Investigación Operativa, Universidad de Valencia (1991).
[107] G. Cornuéjols, J. Fonlupt and D. Naddef, The travelling salesman problem on a graph and some related integer polyhedra, Mathematical Programming 33(1985)1.
[108] G. Cornuéjols and F. Harche, Polyhedral study of the capacitated vehicle routing problem, Mathematical Programming 60(1993)21.
[109] F. Cullen, J. Jarvis and H. D. Ratliff, Set partitioning based heuristics for interactive routing, Networks 11(1981)125.
[110] J.R. Current and M. Marsh, Multiobjective transportation network design and routing problems: Taxonomy and annotation, European Journal of Operational Research 65(1993)4.
[111] J.P. Cyrus, The vehicle scheduling problem: Models, complexity and algorithms, Ph.D. Dissertation, Technical University of Nova Scotia, Halifax, Canada (1988).
[112] C.F. Daganzo, Modelling distribution problems with time windows, Parts I and II, Transportation Science 21(1987)351.
[113] C.F. Daganzo and R.W. Hall, A routing model for pickups and deliveries: No capacity restrictions on the secondary items, Transportation Science 27(1993)313.
[114] G.B. Dantzig, D.R. Fulkerson and S.M. Johnson, Solution of a large-scale travelling salesman problem, Operations Research 2(1954)393–410.
[115] G.B. Dantzig and J.H. Ramser, The truck dispatching problem, Management Science 6(1959)80.
[116] I. Deif and L.D. Bodin, Extension of the Clarke and Wright algorithm for solving the vehicle routing problem with backhauling, in: *Proceedings of the Babson Conference on Software Uses in Transportation and Logistics Management*, ed. A.E. Kidder, Babson Park, MA (1984) p. 75.
[117] P.J. Dejax, A methodology for warehouse location and distribution systems planning, in: *Freight Transport Planning and Logistics*, Lecture Notes in Economics and Mathematical Systems, eds. L. Bianco and A. LaBella (Springer, Berlin and Heidelberg, 1988) p. 289.

[118] M. Dell'Amico, M. Fischetti and P. Toth, Heuristic algorithms for the multi depot vehicle scheduling problem, Management Science 39(1993)115.
[119] U. Derigs and A. Metz, A matching-based approach for solving the delivery pick-up vehicle routing problem with time constraints, Operations Research Spektrum 14 (1992) 91.
[120] U. Derigs and G. Grabenbauer, Intime – A new heuristic approach to the vehicle routing problem with time windows, with a bakery fleet case, American Journal of Mathematical and Management Sciences 13(1993)249.
[121] M. Desrochers, J. Desrosiers and M.M. Solomon, A new optimization algorithm for the vehicle routing problem with time windows, Operations Research 40(1992)342.
[122] M. Desrochers and G. Laporte, Improvements and extensions to the Miller–Tucker–Zemlin subtour elimination constraints, Operations Research Letters 10(1991)27.
[123] M. Desrochers, J.K. Lenstra and M.W.P. Savelsberg, A classification scheme for routing and scheduling problems, European Journal of Operational Research 46(1990)322.
[124] M. Desrochers, J.K. Lenstra, M.W.P. Savelsberg and F. Soumis,Vehicle routing with time windows: Optimization and approximation, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[125] M. Desrochers and T.W. Verhoog, A new heuristic for the fleet size and mix vehicle routing problem, Computers and Operations Research 18(1991)263.
[126] J. Desrosiers, Y. Dumas, M.M. Solomon and F. Soumis, Time constrained routing and scheduling, in: *Handbooks of Operations Research and Management Science: Networks and Distribution*, eds. M. Ball, T. Magnanti, C. Monma and G. Nemhauser (North-Holland, Amsterdam, 1994).
[127] J. Desrosiers, Y. Dumas and F. Soumis, The multiple vehicle dial-a-ride problem, in: *Proceedings of the Fourth International Workshop on Computer-Aided Scheduling of Public Transport*, eds. J.R. Daduna and A. Wren (Springer-Verlag, Berlin, 1988).
[128] J. Desrosiers, Y. Dumas and F. Soumis, A dynamic programming solution for the large-scale sing-vehicle dial-a-ride problem with time windows, American Journal of Mathematical and Management Sciences 6(1986)301.
[129] J. Desrosiers, G. Laporte, M. Sauvé, F. Soumis and S. Taillefer, Vehicle routing with full loads, Computers and Operations Research 15(1988)219.
[130] J. Desrosiers, M. Sauve and F. Soumis, Lagrangian relaxation methods for solving the minimum fleet size multiple traveling salesman problem with time windows, Management Science 34(1988)1005.
[131] J. Desrosiers, F. Soumis and M. Desrochers, Routing with time windows by column generation, Networks 14(1984)545.
[132] J. Desrosiers, F. Soumis, M. Desrochers and M. Sauvé, Methods for routing with time windows, European Journal of Operational Research 23(1986)235.
[133] M. Dror, Modeling vehicle routing with uncertain demands as stochastic program: Properties of the corresponding solution, European Journal of Operational Research 64 (1993)432.
[134] M. Dror and M. Ball, Inventory/routing: reduction from an annual to a short period problem, Naval Research Logistics Quarterly 34(1987)891.
[135] M. Dror, M.O. Ball and B.L. Golden, A computational comparison of algorithms for the inventory routing problem, Annals of Operations Research 4(1985)3.
[136] M. Dror, G. Laporte and F.V. Louveaux, Vehicle routing with stochastic demands and restricted failures, Zeitschrift für Operations Research 37(1993)273.

[137] M. Dror, G. Laporte and P. Trudeau, Vehicle routing with stochastic demands: Properties and solution framework, Transportation Science 23(1989)166.
[138] M. Dror, G. Laporte and P. Trudeau, Vehicle routing with split deliveries, Discrete Applied Mathematics 50(1994)239.
[139] M. Dror and L. Levy, A vehicle routing improvement algorithm: Comparison of a greedy, and a matching implementation for inventory routing, Computers and Operations Research 13(1986)33.
[140] M. Dror, H. Stern and P. Trudeau, Postman tour on a graph with precedence relation on arcs, Networks 17(1987)283.
[141] M. Dror and P. Trudeau, Stochastic vehicle routing problem with modified savings algorithm, European Journal of Operational Research 23(1986)228.
[142] M. Dror and P. Trudeau, Savings by split delivery routing, Transportation Science 23 (1989)141.
[143] M. Dror and P. Trudeau, Split delivery routing, Naval Research Logistics 37(1990)383.
[144] P. Duchessi, S. Belardo and J.P. Seagle, Artificial intelligence and the management science practitioner: Knowledge enhancements to a decision support system for vehicle routing, Interfaces 18(2) (1988) 85.
[145] Y. Dumas, J. Desrosiers, É.Gélinas and M.M. Solomon, An optimal algorithm for the traveling salesman problem with time windows, Operations Research 43(1995)367.
[146] Y. Dumas, J. Desrosiers and F. Soumis, The pickup and delivery problem with time windows, European Journal of Operational Research 54(1991)7.
[147] Y. Dumas, J. Desrosiers and F. Soumis, Large scale multi-vehicle dial-a-ride problems, Cahier du GERAD G-89–30, École des Hautes Études Commerciales, Montréal (1989).
[148] J. Edmonds and E.L. Johnson, Matching, Euler tours and the Chinese postman problem, Mathematical Programming 5(1973)88.
[149] R.W. Eglese, Routing winter gritting vehicles, Discrete Applied Mathematics 48(1994) 231.
[150] R.W. Eglese and L.Y.O. Li, Efficient routing for winter gritting, Journal of the Operational Research Society 43(1992)1031.
[151] R.W. Eglese and H. Murdock, Routing road sweepers in a rural area, Journal of the Operational Research Society 42(1991)281.
[152] S. Eilon, C.D.T. Watson-Gandy and N. Christofides, in: *Distribution Management: Mathematical Modelling and Practical Analysis* (Griffin, London, 1971).
[153] H.A. Eiselt, M. Gendreau and G. Laporte, Arc routing problems. Part I: The Chinese postman problem, Operations Research 43(1995)231.
[154] H.A. Eiselt, M. Gendreau and G. Laporte, Arc routing problems. Part II: The rural postman problem, Operations Research 43(1995)399.
[155] H.A. Eiselt and G. Laporte, Integrated planning in distribution systems, International Journal of Physical Distribution and Materials Management 19(1989)14.
[156] H.A. Eiselt and G. Laporte, A combinatorial optimization problem arising in dartboard design, Journal of the Operational Research Society 42(1991)113.
[157] H. El Ghaziri, Solving routing problems by a self-organizing map, in: *Artificial Neural Networks*, eds. T. Kohonen, K. Makisara, O. Simula and J. Kangas (North-Holland, Amsterdam, 1991).
[158] T. Etazadi and J.E. Beasley, Vehicle fleet composition, Journal of the Operational Research Society 34(1983)87.

[159] L. Euler, Solutio problematis ad geometrian situs pertinentis, Commentarii academiae scientarum Petropolitanae 8(1736)128.
[160] L. Euler, Leonhard Euler and the Königsberg bridges, Scientific American 189(1953)66.
[161] J.R. Evans and E. Minieka, *Optimization Algorithms for Networks and Graphs* (Marcel Dekker, New York, 1992).
[162] S. Evans and J. Norback, The impact of a decision-support system for vehicle routing in a food service supply situation, Journal of the Operational Research Society 36 (1985)467.
[163] R. Fahrin and M. Wrede, On a principle of chain-exchange for vehicle-routing problems (1-VRP), Journal of the Operational Research Society 41(1990)821.
[164] A. Federgruen and P. Zipkin, A combined routing and inventory allocation problem, Operations Research 32(1984)1019.
[165] J.A. Ferland and L. Fortin, Vehicle routing with sliding time windows, European Journal of Operational Research 38(1989)213.
[166] J.A. Ferland and P. Michelon, The vehicle routing with multiple types, Journal of the Operational Research Society 39(1988)577.
[167] C.-N. Fiechter, A parallel tabu search algorithm for large scale traveling salesman problems, Discrete Applied Mathematics 51(1994)243.
[168] G. Finke, A. Claus and E. Gunn, A two-commodity network flow approach to the traveling salesman problem, Congressus Numerantium 41(1984)167.
[169] M. Fischetti, J.J.S. Gonzalez and P. Toth, A branch and cut algorithm for the symmetric generalized travelling salesman problem, Working paper, DEIS, University of Bologna, Italy (1993).
[170] M. Fischetti, G. Laporte and S. Martello, The delivery man problem and cumulative matroids, Operations Research 41(1993)1055.
[171] M. Fischetti and P. Toth, An additive bounding procedure for the asymmetric travelling salesman problem, Mathematical Programming 53(1992)173.
[172] M. Fischetti and P. Toth, An additive approach for the optimal solution of the prize collecting travelling salesman problem, in: *Vehicle routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[173] M. Fischetti, P. Toth and D. Vigo, A branch-and-bound algorithm for the capacitated vehicle routing problem on directed graphs, Operations Research 42(1994)846.
[174] M.L. Fisher, Lagrangean optimization algorithms for vehicle routing problems, in: *Operational Research '87*, IFORS, ed. G.K. Rand (North-Holland, Amsterdam, 1988) p. 635.
[175] M.L. Fisher, Optimal solution of vehicle routing problems using minimum K-trees, Operations Research 42(1994)626.
[176] M.L. Fisher, Vehicle routing, in: *Handbooks on Operations Research and Management Science, Networks and Distribution* (North-Holland, Amsterdam, 1995).
[177] M.L. Fisher and R. Jaikumar, A generalized assignment heuristic for vehicle routing, Networks 11(1981)109.
[178] M.L. Fisher, H. Jiegang and T. Bao-Xing, Scheduling of bulk pickup delivery vehicles in Shanghai, Interfaces 16(2) (1986) 18.
[179] M.L. Fisher, K.O. Jörnsten and O.B.G. Madsen, Vehicle routing with time windows: Preliminary results, Research Report 4C/91, IMSOR, The Technical University of Denmark, Lyngby, Denmark (1992).

[180] M.L. Fisher, B. Tang and Z. Zhen, A network-flow based heuristic for bulk pickup and delivery routing, Transportation Science 29(1995)45.
[181] B. Fleischmann, A new class of cutting planes for the symmetric travelling salesman problem, Mathematical Programming 40(1988)225.
[182] H. Fleischner, Eulerian graphs and related topics (Part 1, Volume 1), Annals of Discrete Mathematics 45 (North-Holland, Amsterdam, 1990).
[183] H. Fleischner, Eulerian graphs and related topics (Part 1, Volume 2), Annals of Discrete Mathematics 50 (North-Holland, Amsterdam, 1991).
[184] H. Fleuren, A computational study of the set partitioning approach for vehicle routing and scheduling problems, Ph.D. Dissertation, University of Twente, The Netherlands (1988).
[185] C. Foisy and J.V. Potvin, Implementing an insertion heuristic for vehicle routing on parallel hardware, Computers and Operations Research 20(1993)737.
[186] P.M. França, M. Gendreau, G. Laporte and F.M. Müller, The *m*-traveling salesman problem with minmax objective, Transportation Science 29(1995)267.
[187] G.N. Frederickson, Approximation algorithms for some postman problems, Journal of the Association for Computing Machinery 26(1979)538.
[188] G.N. Frederickson, M.S. Hecht and C.E. Kim, Approximation algorithms for some routing problems, SIAM Journal on Computing 7(1978)178.
[189] M.L. Freedman, D.S. Johnson, L.A.M.C. Geoch and G. Ostreimer, Data structures for traveling salesman, in: *Proceedings of the Fourth Annual ACM-SIAM Symposium on Discrete Algorithms* (Association for Computing Machinery, New York, 1993) p. 145.
[190] P.W. Frizzell and J.W. Giffin, The bounded split delivery vehicle-routing problem with grid network distances, Asia-Pacific Journal of Operational Research 19(1992)101.
[191] B.L. Garcia, J.-Y. Potvin and J.-M. Rousseau, A parallel implementation of the tabu search heuristic for vehicle routing problems with time window constraints, Computers and Operations Research 21(1994)1025.
[192] M.R. Garey and D.S. Johnson, *Computers and Intractability. A Guide to the Theory of NP-Completeness* (Freeman, New York, 1979).
[193] M. Gaudioso and G. Paletta, A heuristic for the periodic vehicle routing problem, Transportation Science 26(1992)86.
[194[B. Gavish and S.C. Graves, Scheduling and routing in transportation and distribution systems: Formulations and new relaxations, Working Paper, Graduate School of Management, University of Rochester (1982).
[195] B. Gavish and K.N. Srikanth, An optimal solution method for large-scale multiple traveling salesmen problems, Operations Research 34(1986)698.
[196] É. Gélinas, Le problème du postier chinois avec contraintes générales de préséance, M.Sc.A. Dissertation, École Polytechnique de Montréal (1992).
[197] S. Gélinas, M. Desrochers, J. Desrosiers and M.M. Solomon, Vehicle routing with backhauling, Cahiers du GERAD G-92-13, École des Hautes Études Commerciales, Montréal (1992).
[198] M. Gendreau, A. Hertz and G. Laporte, New insertion and post-optimization procedures for the traveling salesman problem, Operations Research 40(1992)1086.
[199] M. Gendreau, A. Hertz and G. Laporte, A tabu search heuristic for the vehicle routing problem, Management Science 40(1994)1276.
[200] M. Gendreau, A. Hertz and G. Laporte, The traveling salesman problem with backhauls, Computers and Operations Research, forthcoming.

[201] M. Gendreau, G. Laporte and J.-Y. Potvin, Local search algorithms for the vehicle routing problem, in: *Local Search Algorithms*, eds. J.K. Lenstra and E.H.L. Aarts (Wiley, Chichester, 1994).
[202] M. Gendreau, G. Laporte and R. Séguin, A tabu search heuristic for the vechicle routing problem with stochastic demands and customers, Operations Research, forthcoming.
[203] M. Gendreau, G. Laporte and R. Séguin, An exact algorithm for the vehicle routing problem with stochastic demands and customers, Transportation Science 29(1995)143.
[204] M. Gendreau, G. Laporte and M.M. Solomon, Single-vehicle routing and scheduling to minimize the number of missed deadlines, Transportation Science, forthcoming.
[205] M. Gendreau, G. Laporte and Y. Zhao, The windy postman problem on general graphs, Publication #698, Centre de recherche sur les transports, Montréal (1990).
[206] F.G. Gheysens, B.L. Golden and A.A. Assad, A comparison of technique for solving the fleet size and mix routing problem, Operations Research Spektrum 6(1984)207.
[207] F.G. Gheysens, B.L. Golden and A.A. Assad, A new heuristic for determining fleet size and composition, Mathematical Programming Studies 26(1986)233.
[208] F. Glover, Ejection chains, reference structures and alternating path methods for travelling salesman problems, Discrete Applied Mathematics, forthcoming.
[209] M. Goetschalckx and C. Jacobs-Blecha, The vehicle routing problem with backhauls, European Journal of Operational Research 42(1989)39.
[210] B.L. Golden and A.A. Assad, Perspectives on vehicle routing: Exciting new developments, Operations Research 34(1986)803.
[211] B.L. Golden and A.A. Assad, *Vehicle Routing: Methods and Studies* (North-Holland, Amsterdam, 1988).
[212] B.L. Golden, A.A. Assad and R. Dahl, Analysis of a large-scale vehicle routing problem with an inventory component, Large Scale Systems Theory and Applications 7(1984)181.
[213] B.L. Golden, A.A. Assad, L. Levy and F. Gheysens, The fleet size and mix vehicle routing problem, Computers and Operations Research 11(1984)49.
[214] B.L. Golden, L.D. Bodin and T. Goodwin, Micro-computer-based vehicle routing and scheduling software, Computers and Operations Research 13(1986)277.
[215] B.L. Golden, J.S. DeArmon and E.K. Baker, Computational experiments with algorithms for a class of routing problems, Computers and Operations Research 10(1983)47.
[216] B.L. Golden, L. Levy and R. Vohra, The orienteering problem, Naval Research Logistics 34(1987)307.
[217] B.L. Golden and C.C. Skiscim, Using simulated annealing to solve routing and location problems, Naval Research Logistics Quarterly 33(1986)261.
[218] B.L. Golden, Q. Wang and L. Liu, A multifaceted heuristic for the orienteering problem, Naval Research Logistics 35(1988)359.
[219] B.L. Golden and E.A. Wasil, Computerized vehicle routing in the soft drink industry, Operations Research 35(1987)6.
[220] B.L. Golden and R.T. Wong, Capacitated arc routing problems, Networks 11(1981)305.
[221] M. Grötschel and O. Holland, Solution of large-scale symmetric travelling salesman problems, Mathematical Programming 51(1991)141.
[222] M. Grötschel and M.W. Padberg, Polyhedral theory, in: *The Traveling Salesman Problem. A Guided Tour of Combinatorial Optimization*, eds. E.L. Lawler, J.K. Lenstra, A.H.G. Rinnooy Kan and D.B. Shmoys (Wiley, Chichester, 1985).

[223] M. Grötschel and Z. Win, On the windy postman polyhedron, Report No. 75, Schwerpunktprogram der Deutschen Forschungsgemeinschaft, Universität Augsburg (1988).
[224] M. Grötschel and Z. Win, A cutting plane algorithm for the windy postman problem, Mathematical Programming 55(1992)339.
[225] J. Gu and X.F. Huang, Efficient local search with search space smoothing – a case-study of the traveling salesman problem (TSP), IEEE Transactions on Systems, Man and Cybernetics 24(1994)728.
[226] M. Guan, Graphic programming using odd and even points, Chinese Mathematics 1 (1962)273.
[227] M. Guan, On the windy postman problem, Discrete Applied Mathematics 9(1984)41.
[228] M. Guan, A survey of the Chinese postman problem, Journal of Mathematical Research and Exposition 4(1984)113 (in Chinese).
[229] M. Guan and W. Pulleyblank, Eulerian orientations and circulations, SIAM Journal on Algebra and Discrete Mathematics 6(1985)657.
[230] M. Haimovich and A.H.G. Rinnooy Kan, Bounds and heurisitics for capacitated routing problems, Mathematics of Operations Research 10(1985)527.
[231] M. Haimovich, A.H.G. Rinnooy Kan and L. Stougie, Analysis of heuristics for vehicle routing problems, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[232] D.T. Hiquebran, A.S. Alfa, J.A. Shapiro and D.H. Gittoes, A revised simulated annealing and cluster-1st route-2nd algorithm applied to the vehicle-routing problem, Engineering Optimization 22(1994)77.
[233] R.W. Hall, A note on bounds for direct shipping cost, Management Science 38(1992) 1212.
[234] K. Halse, Modeling and solving complex vehicle routing problems, Ph.D. Dissertation No. 60, IMSOR, Technical University of Denmark, Lyngby (1992).
[235] P.H. Hansen, B. Hegedahl, S. Hjortkjaer and B. Obel, A heuristic solution to the warehouse location-routing problem, European Journal of Operational Research 76 (1994)111.
[236] M. Haouari, P. Dejax and M. Desrochers, Les problèmes de tournées avec contraintes de fenêtres de temps, l'état de l'art, RAIRO (Recherche opérationnelle) 24(1990)217.
[237] E. Haslam and J.R. Wright, Application of routing technologies to rural snow and ice control, Transportation Research Record No. 1304 (1991)202.
[238] C. Hierholzer, Über die Möglichkeit, einen Linienzug ohne Wiederholung und ohne Unterbrechung zu umfahren, Mathematische Annalen VI(1873)30.
[239] A.J. Hoffman and P. Wolfe, History, in: *The Traveling Salesman Problem. A Guided Tour of Combinatorial Optimization*, eds. E.L. Lawler, J.K. Lenstra, A.H.G. Rinnooy Kan and D.B. Shmoys (Wiley, Chichester, 1985).
[240] J.N. Holt and A.M. Watts, Vehicle routing in the newspaper industry, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[241] J.N. Hooker and N.R. Natraj, Routing and scheduling by modified chain decomposition and tabu search, Transportation Science 29(1995)30.
[242] Institute of Logistics and Distribution Management, The 1985 Survey of Distribution Costs, Douglas House, Queen's Square, Corby, Northants, U.K.

[243] I. Ioachim, J. Desrosiers, Y. Dumas and M.M. Solomon, A request clustering algorithm for door-to-door handicapped transportation, Transportation Science 29(1995)63.

[244] A. Itai, R.J. Lipton, C.H. Papadimitriou and M. Rodeh, Covering graphs by simple circuits, SIAM Journal on Computing 10(1981)746.

[245] A. Itai and M. Rodeh, Covering a graph by circuits, Lecture Notes in Computer Science 62(1978)289.

[246] C. Jacobs-Blecha and M. Goetschalckx, The vehicle routing problem with backhauls: Properties and solution algorithms, Report MHRC-TR-8813, Material Handling Center, Atlanta (1993).

[247] P. Jaillet, Probabilistic traveling salesman problem, Ph. D. Thesis, Massachusetts Institute of Technology, MA (1985).

[248] P. Jaillet, A priori solution of a traveling salesman problem in which a random subset of the customers are visited, Operations Research 36(1988)929.

[249] K. Jansen, Bounds for the general capacitated routing problem, Networks 23(1993)165.

[250] J. Jaw, A. Odoni, H. Psaraftis and N. Wilson, A heuristic algorithm for the multi-vehicle advance-request dial-a-ride problem with time windows, Transportation Research 20(1986)243.

[251] C.S. Jeong and M.H. Kim, Fast machine parallel simulated annealing for traveling salesman problem on SIMD-machines with linear interconnections, Parallel Computing 17(1991)221.

[252] D.S. Johnson, Local optimization and the travelling salesman problem, *Proceedings of the 17th International Colloquium on Automata, Languages and Programming*, Lecture Notes in Computer Science (Springer, Berlin, 1990) p. 446.

[253] K. Jörnsten, O.B.G. Madsen and B. Sørensen, Exact solution of the vehicle routing and scheduling problem with time windows by variable splitting, Research Report 5/86, IMSOR, The Technical University of Denmark, Lyngby (1986).

[254] M. Jünger, G. Reinelt and S. Thienel, Probably good solutions for the traveling salesman problem, Report No. 92.114, Institut für Informatik, Universität zu Köln (1992).

[255] N. Kadaba, K.E. Nygard and P.L. Juell, Integration of adaptive machine learning and knowledge-based systems for routing and scheduling applications, Expert Systems with Applications 2(1991)15.

[256] S. Kagaya, S. Kikuchi and R.A.Donnelly, Use of a fuzzy theory technique for grouping of trips in the vehicle routing and scheduling problem, European Journal of Operational Research 76(1994)143.

[257] C.H. Kappauf and G.J. Koehler, The mixed postman problem, Discrete Applied Mathematics 1(1979)89.

[258] C.P. Keller, Algorithms to solve the orienteering problem: A comparison, European Journal of Operational Research 41(1989)224.

[259] D.Y. Kesel'man, Covering the edges of a graph by circuit, Kibernetica 3(1987)16. (Translated from Russian).

[260] T. Kim, Solution algorithms for sealift routing and scheduling problems, Ph.D. Dissertation, Massachusetts Institute of Technology (1985).

[261] G.A.P. Kinderwater and M.W.P. Savelsbergh, Local search in physical distribution, in: *Local Search Algorithms*, eds. J.K. Lenstra and E.H.L. Aarts (Wiley, Chichester, 1996).

[262] J. Knox, An application of TABU search to the symmetric traveling salesman problem, Ph.D. Thesis, Center for Applied Artificial Intelligence (CAAI), Graduate School of Business, University of Colorado (1988).
[263] J. Knox, Tabu search performance on the symmetric traveling salesman problem, Computers and Operations Research 21(1994)867.
[264] A.W.J. Kolen, A.H.J. Rinnooy Kan and H.W.J.M. Trienekens, Vehicle routing with time windows, Operations Research 35(1987)266.
[265] G. Kontoravdis and J.F. Bard, Improved heuristics for the vehicle routing problem with time windows, Working Paper, Department of Mechanical Engineering, The University of Texas, Austin (1992).
[266] H. Kopfer, G. Pankratz and E. Erkens, Development of a hybrid genetic algorithm for vehicle-routing, Operations Research Spektrum 16(1994)21.
[267] E. Korach and M. Penn, Tight integral duality gap in the Chinese postman problem, Mathematical Programming 55(1992)183.
[268] Y.A. Koskosidis and W.B. Powell, Applications of optimization based models on vehicle routing and scheduling problems with time window constraints, Journal of Business Logistics 11(1990)101.
[269] Y.A. Koskosidis, W.B. Powell and M.M. Solomon, An optimization-based heuristic for vehicle routing and scheduling with soft time window constraints, Transportation Science 26(1992)69.
[270] M. Kubo and H. Kasugai, Heuristic algorithms for the dial-a-ride routing problem, Journal of the Operations Research Society of Japan 33(1990)335.
[271] M. Kubo and H. Kasugai, The precedence constrained travelling salesman problem, Journal of the Operations Research Society of Japan 34(1991)152.
[272] R.V. Kulkarni and P.R. Bhave, Integer programming formulations of vehicle routing problems, European Journal of Operational Research 20(1985)58.
[273] M. Labbé, G. Laporte and H. Mercure, Capacitated vehicle routing on trees, Operations Research 39(1991)616.
[274] B.J. LaLonde and P.H. Zinszer, Customer service: meaning and measurement, National Council of Physical Distribution Management, Chicago (1976).
[275] A. Lamatsch, An approach to vehicle scheduling with depot capacity constraints, Lecture Notes in Economics and Mathematical Systems 386(1992)181.
[276] V. Lambert, G. Laporte and F.V. Louveaux, Designing money collection routes through bank branches, Computers and Operations Research 20(1993)783.
[277] A.H. Land, The solution of some 100-city travelling salesman problems, Working Paper, London School of Economics (1979).
[278] A. Langevin and F. Soumis, Design of multi-vehicle delivery tours satisfying time constraints, Transportation Research B, 23(1989)123.
[279] A. Langevin, F. Soumis and J. Desrosiers, Classification of travelling salesman problem formulations, Operations Research Letters 9(1990)127.
[280] G. Laporte, Generalized subtour elimination constraints and connectivity constraints, Journal of the Operational Research Society 37(1986)509.
[281] G. Laporte, Location-routing problems, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[282] G. Laporte, Développements algorithmiques récents de recherche en distributique, Les Cahiers Scientifiques du Transport 21(1990)61.

[283] G. Laporte, The traveling salesman problem: An overview of exact and approximate algorithms, European Journal of Operational Research 59(1992)231.
[284] G. Laporte, The vehicle routing problem: An overview of exact and approximate algorithms, European Journal of Operational Research 59(1992)345.
[285] G. Laporte and P.J. Dejax, Dynamic location-routing problems, Journal of the Operational Research Society 40(1989)471.
[286] G. Laporte and F.V. Louveaux, Formulations and bounds for the stochastic vehicle routing problem with uncertain supplies, in: *Economic Decision-Making: Games, Econometrics and Optimization*, eds. J.J. Gabszewicz, J.-F. Richard and L.A. Wolsey (North-Holland, Amsterdam, 1990).
[287] G. Laporte and F.V. Louveaux, The integer L-shaped method for stochastic integer programs with complete recourse, Operations Research Letters 13(1993)133.
[288] G. Laporte, F.V. Louveaux and H. Mercure, The vehicle routing problem with stochastic travel times, Transportation Science 26(1992)161.
[289] G. Laporte, F. V. Louveaux and H. Mercure, Models and exact solutions for a class of stochastic location-routing problems, European Journal of Operational Research 39(1989)71.
[290] G. Laporte, F.V. Louveaux and H. Mercure, A priori optimization of the probabilistic travelling salesman problem, Operations Research 42(1994)543.
[291] G. Laporte and S. Martello, The selective travelling salesman problem, Discrete Applied Mathematics 16(1990)193.
[292] G. Laporte, H. Mercure and Y. Nobert, Optimal tour planning with specified nodes, RAIRO (Recherche opérationnelle) 18(1984)203.
[293] G. Laporte, H. Mercure and Y. Nobert, An exact algorithm for the asymmetrical capacitated vehicle routing problem, Networks 16(1986)33.
[294] G. Laporte, H. Mercure and Y. Nobert, A branch-and-bound algorithm for a class of asymmetrical vehicle routing problems, Journal of the Operational Research Society 43(1992)469.
[295] G. Laporte and Y. Nobert, Exact algorithms for the vehicle routing problem, in: *Surveys in Combinatorial Optimization*, eds. S. Martello, G. Laporte, M. Minoux and C. Ribeiro (North-Holland, Amsterdam, 1984).
[296] G. Laporte and Y. Nobert, Generalized travelling salesman problem through sets of nodes: An integer programming approach, INFOR 21(1983)61.
[297] G. Laporte and Y. Nobert, A branch and bound algorithm for the capacitated vehicle routing problem, Operations Research Spektrum 5(1983)77.
[298] G. Laporte, N. Nobert and D. Arpin, An exact algorithm for solving a capacitated location-routing problem, Annals of Operations Research 9(1986)293.
[299] G. Laporte, Y. Nobert and M. Desrochers, Optimal routing under capacity and distance restrictions, Operations Research 33(1985)1050.
[300] G. Laporte, Y. Nobert and S. Taillefer, Solving a family of multi-depot vehicle routing and location-routing problems, Transportation Science 22(1988)161.
[301] G. Laporte, Y. Nobert and S. Taillefer, A branch-and-bound algorithm for the asymmetrical distance-constrained vehicle routing problem, Mathematical Modelling 9(1987)857.
[302] R.C. Larson, A. Minkoff and P. Gregory, Fleet sizing and dispatching for the marine division of the New York city department of sanitation, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).

[303] E.L. Lawler, J.K. Lenstra, A.H.G. Rinnooy Kan and D.B. Shmoys, *The Traveling Salesman Problem, A Guided Tour of Combinatorial Optimization* (Wiley, Chichester, 1985).
[304] J.Y. Lee and M.Y. Choi, Optimization by multicanonical annealing and the traveling salesman problem, Physical Review E, 50 Part A (1994) R651.
[305] A.C. Leifer and M.B. Rosenwein, Strong linear programming relaxations for the orienteering problem, European Journal of Operational Research 73(1994)517.
[306] P.F. Lemieux and L. Campagna, The snow ploughing problem solved by a graph theory algorithm, Civil Engineering Systems 1(1984)337.
[307] J.K. Lenstra and A.H.G. Rinnooy Kan, Complexity of vehicle routing and scheduling problems, Networks 11(1981)221.
[308] L. Levy, The walking line of travel problem: An application of arc routing and partitioning, Ph.D. Dissertation, University of Maryland (1987).
[309] L. Levy and L.D. Bodin, Scheduling the postal carriers for the United States Postal Service: An application of arc partitioning and routing, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[310] L. Levy and L.D. Bodin, The arc oriented location routing problem, INFOR 27(1989)74.
[311] C.L. Li and D. Simchi-Levi, Worst-case analysis of heuristics for multidepot capacitated vehicle routing problems, ORSA Journal on Computing 2(1990)64.
[312] C.L. Li, D. Simchi-Levi and M. Desrochers, On the distance constrained vehicle routing problem, Operations Research 40(1992)790.
[313] L.Y.O. Li, Vehicle routing for winter gritting, Ph.D. Dissertation, Dept. of O.R. and O.M., Lancaster University, U.K. (1992).
[314] T.M. Liebling, Graphentheorie in planungs- und Tourenproblemen, Lecture Notes in Operations Research and Mathematical Systems 21 (Springer, Berlin, 1970).
[315] Y. Lin and Y. Zhao, A new algorithm for the directed Chinese postman problem, Computers and Operations Research 15(1988)577.
[316] A. Lucena, Time-dependent travelling salesman problem: The delivery man case, Networks 20(1990)753.
[317] A. Lucena, Exact solution approaches for the vehicle routing problem, Ph.D. Thesis, Department of Management Science, Imperial College, London (1986).
[318] A. Lukka, On method and system design for a problem in vehicle routing and scheduling, Academic Dissertation, Lappeenranta University of Technology, Finland (1987).
[319] A. Lukka and L. Salminen, Comparison of three heuristics for an arc routing problem, Research Report 6/1987, Department of Information Technology, Lappeenranta University of Technology, Finland (1987).
[320] J. Lysgaard, Dynamic transportation networks in vehicle routing and scheduling, Interfaces 22(3) (1992) 45.
[321] B. Macleod and R. Moll, A toolkit for vehicle routing, in: *Systems Integration '90, Proceedings of the First International Conference on Systems Integration*, eds. L.C. Seifert and R.T. Yeh (Ng, P.A., C.V. Ramamoorthy, 1990) p. 426.
[322] O.B.G. Madsen, Methods for solving combined two level location-routing problems for realistic dimensions, European Journal of Operational Research 12(1983)295.
[323] K.-T. Mak and A.J. Morton, A modified Lin–Kernighan traveling-salesman heuristic, Operations Research Letters 13(1993)127.
[324] C. Malandraki and M.S. Daskin, Time dependent vehicle routing problems: Formulations, properties and heuristic algorithms, Transportation Science 26(1992)185.

[325] M. Malek, Search methods for traveling salesman problems, Working Paper, University of Texas, Austin (1988).
[326] M. Malek, M. Guruswamy, H. Owens and M. Panday, Serial and parallel techniques for the travelling salesman problem, Annals of Operations Research 21(1989)59.
[327] M. Malek, A. Mourad and M. Pandya, Topological testing, *Proceedings of the IEEE 1989 International Test Conference*, paper 4.4 (1989) p. 103.
[328] F. Margot, Quick updates for *p*-opt TSP heuristics, Operations Research Letters 11(1992)45.
[329] G.T. Martin, Solving the travelling salesman problem by integer programming, Working Paper, CEIR, New York (1966).
[330] O. Martin, S.W. Otto and E.W. Felten, Large-step Markov chains for the TSP incorporating local search heuristics, Operations Research Letters 11(1992)219.
[331] B.P. Mathews and C.D.J. Waters, Computerized routing for community nurses – a pilot study, Journal of the Operational Research Society 37(1986)677.
[332] R. McBride, Controlling left and U-turns in the routing of refuse collection vehicles, Computers and Operations Research 9(1982)145.
[333] K. Menger, Das Botenproblem, in: Ergebmisse eines Mathematischen Kolloquiums 2, ed. K. Menger (Teubner, Leipzig, 1932).
[334] M. Mesquita and J. Paixao, Multiple depot vehicle scheduling problem: A new heuristic based on quasi-assignment algorithms, Lecture Notes in Economics and Mathematical Systems 386(1992)181.
[335] D.L. Miller, A matching based exact algorithm for capacitated vehicle routing, ORSA Journal on Computing 7(1995)1.
[336] D.L. Miller and J.-F. Pekny, Results from a parallel branch and bound algorithm for solving large asymmetrical traveling salesman problems, Operations Research Letters 8(1989)129.
[337] M.K. Min, The multiple vehicle routing problem with simultaneous delivery and pick-up points, Transportation Science A 23 (1989) 377.
[338] M.K. Min, A multiobjective vehicle routing problem with soft time windows – the case of public-library distribution system, Socio-Economic Planning Sciences 25(1991)179.
[339] M.K. Min, J. Current and D. Schilling, The multiple depot vehicle routing problem with backhauling, Journal of Business Logistics 13(1992)259.
[340] A. Mingozzi, N. Christofides and E. Hadjiconstantinou, An exact algorithm for the vehicle routing problem based on the set partitioning formulation. Working paper, University of Bologna, Italy (1994).
[341] E. Minieka, The Chinese postman problem for mixed networks, Management Science 25(1979)643.
[342] E. Minnazzato, La raccolta dei rifiuti solidi urbani nella città di Como: Modelli e algorithmi di ricerca operativa, Tesi di Laurea in Scienze Statistiche ed Economiche, Università degli Studi di Padova (1988).
[343] J. Mittenthal and C.E. Noon, An insert delete heuristic for the traveling salesman – tour problem with one additional constraint, Journal of the Operational Research Society 43(1992)277.
[344] R.H. Mole, Dynamic optimization of vehicle fleet size, Operational Research Quarterly 26(1975)25.
[345] R.H. Mole, D.G. Johnson and K. Wells, Combinatorial analysis for route 1st cluster 2nd vehicle routing, Omega 11(1983)507.
[346] H. Müller-Merbach, Zweimal travelling salesman, DGOR-Bulletin 25(1983)12.

[347] D. Naddef, A remark on "Integer linear programming formulation for a vehicle routing problem" by N.R. Achutan and L.Caccetta, or how to use the Clarke & Wright savings to write such integer linear programming formulations, European Journal of Operational Research 75(1994)238.
[348] D. Naddef and G. Rinaldi, The symmetric travelling salesman polytope and its graphic relaxation: Composition of valid inequalities, Mathematical Programming 51(1991)359.
[349] B. Nag, Vehicle routing in the presence of site/vehicle dependency constraints, Ph.D. Thesis, University of Maryland, College Park, MD (1986).
[350] J.M. Nambiar, L.F. Gelders and L.N. van Wassenhove, Plant location and vehicle routing in the Malaysian rubber smallholder sector: A case study, European Journal of Operational Research 38(1989)14.
[351] M. Negreiros, O problema de planejamento e percuso de veículos na coleta do lixo urbano domiciliar, M.Sc. Dissertation, Sistemas/COPPE, Federal University of Rio de Janeiro (1989).
[352] M.D. Nelson, K.E. Nygard, J.H. Griffin and W.E. Shreve, Implementation techniques for the vehicle routing problem, Computers and Operations Research 12(1985)273.
[353] Y. Nobert and J.-C. Picard, An optimal algorithm for the mixed Chinese postman problem, Networks, forthcoming.
[354] C.E. Noon and J.C. Bean, A Lagrangian based approach for the asymmetric generalized traveling salesman problem, Operations Research 39(1991)623.
[355] C.E. Noon and J.C. Bean, An efficient transformation of the generalized traveling salesman problem, INFOR 31(1993)39.
[356] K.E. Nygard, P. Greenberg, W.E. Bolkan and E.J. Swenson, Generalized assignment methods for the deadline vehicle routing problem, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[357] K.E. Nygard and P.L. Juell, Integration of adaptive machine learning and knowledge-based systems for routing and scheduling applications, Expert Systems with Applications 2(1991)15.
[358] B.F. O'Neil and M.R.W. Bommer, Computer-assisted vehicle routing systems, International Journal of Physical Distribution and Materials 19(1989)11.
[359] H.L. Ong, T.N. Goh, K.L. Poh and C.C. Lim, A computerized vehicle routing system for refuse collection, Advances in Engineering Software 12(1990)54.
[360] H.L. Ong and H.C. Huang, Asymptotic expected performance of some TSP heuristics, European Journal of Operational Research 43(1989)231.
[361] C.S. Orloff, A fundamental problem in vehicle routing, Networks 4(1974)35.
[362] I.H. Osman, Metastrategy simulated annealing and tabu search algorithms for combinatorial optimization problems, Ph.D. Thesis, Imperial College, The Management School, University of London (1991).
[363] I.H. Osman, Metastrategy simulated annealing and tabu search algorithms for the vehicle routing problem, Annals of Operations Research 41(1993)421.
[364] I.H. Osman, Vehicle routing and scheduling: Applications, algorithms and developments, *Proceedings of the International Conference on Industrial Logistics*, Rennes, France (1993).
[365] I.H. Osman and G. Laporte, Metaheuristics for combinatorial optimization problems: An annotated bibliography, forthcoming in Annals of Operations Research on "Metaheuristics in Combinatorial Optimization", eds. G. Laporte and I.H. Osman (1996).

[366] I.H. Osman and S. Salhi, Local search strategies for the mix fleet vehicle routing problem, Report No. UKC/IMS/OR93/8, Institute of Mathematics and Statistics, University of Kent, Canterbury, U.K. (1993).
[367] M.W. Padberg and M. Grötschel, Polyhedral computations, in: *The Traveling Salesman Problem. A Guided Tour of Combinatorial Optimization*, eds. E.L. Lawler, J.K. Lenstra, A.H.G. Rinnooy Kan and D.B. Shmoys (Wiley, Chichester, 1985) p. 307.
[368] M.W. Padberg and G. Rinaldi, Optimization of a 532-city symmetric traveling salesman problem by branch and cut, Operations Research Letters 6(1987)1.
[369] M.W. Padberg and G. Rinaldi, Facet identification for the symmetric traveling salesman problem, Mathematical Programming 47(1990)219.
[370] M.W. Padberg and G. Rinaldi, A branch-and-cut algorithm for the resolution of large-scale symmetric traveling salesman problems, SIAM Review 33(1991)60.
[371] M.W. Padberg and T.-Y. Sung, An analytical comparison of different formulations of the travelling salesman problem, Mathematical Programming 52(1991)315.
[372] H. Paessens, The savings algorithms for the vehicle routing problem, European Journal of Operational Research 3 (1988)336.
[373] C.H. Papadimitriou, On the complexity of edge traversing, Journal of the Association for Computing Machinery 23(1976)544.
[374] C.H. Papadimitriou, The complexity of the Lin–Kernighan heuristic for the traveling salesman problem, SIAM Journal on Computing 21(1992)450.
[375] U. Pape, Car transportation, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[376] Y.B. Park and C.P. Koelling, An interactive computerized algorithm for multicriteria vehicle routing problem, Computers and Industrial Engineering 16(1989)477.
[377] S.C. Parikh, On the fleet size and allocation problem, Management Science 23(1977)972.
[378] W.-L. Pearn, The capacitated Chinese postman problem, Ph.D. Thesis, University of Maryland (1984).
[379] W.-L. Pearn, New lower bounds for the capacitated arc routing problem, Computers and Operations Research 16(1989)589.
[380] W.-L. Pearn, Approximate solutions for the capacitated arc routing problem, Computers and Operations Research 16(1989)589.
[381] W.-L. Pearn, Augment-insert algorithms for the capacitated arc routing problem, Computers and Operations Research 18(1991)189.
[382] W.-L. Pearn, A.A. Assad and B.L. Golden, Transforming arc routing into node routing problems, Computers and Operations Research 14(1987)285.
[383] W.L. Pearn and M.L. Li, Algorithms for the windy postman problem, Computers and Operations Research 21(1994)641.
[384] J.F. Pekny and D.L. Miller, A parallel branch-and-bound algorithm for solving large asymmetric traveling salesman problems, Mathematical Programming 55(1992)17.
[385] J. Pooley, A vehicle routing algorithm for the less-than-truck load vs. multiple-stop problem, Journal of Business Logistics 13(1992)239.
[386] J. Pooley, Integrated production and distribution facility planning at Ault Foods, Interfaces 24(4) (1994) 113.
[387] J.-Y. Potvin, Un système informatique pour le développement et l'expérimentation d'algorithmes de génération de tournées, Thèse de doctorat, Département d'informatique et de recherche opérationnelle, Université de Montréal (1987).

[388] J.-Y. Potvin, The travelling salesman problem: A neural network perspective, ORSA Journal on Computing 5(1993)328.
[389] J.-Y. Potvin, Genetic algorithms for the travelling salesman problem, forthcoming in Annals of Operations Research on "Metaheuristics in Combinatorial Optimization", eds. G.Laporte and I.H. Osman (1996).
[390] J.-Y. Potvin, D. Dubé and C. Robillard, A hybrid approach to vehicle routing using neural networks and genetic algorithm, Applied Intelligence, forthcoming.
[391] J.-Y. Potvin, T. Kervahut and J.-M. Rousseau, A tabu search heuristic for the vehicle routing problem with time windows, ORSA Journal on Computing, forthcoming.
[392] J.-Y. Potvin, G. Lapalme and J.-M. Rousseau, Integration of AI and OR techniques for computer-aided algorithmic design in the vehicle domain, Journal of the Operational Research Society 41(1990)517.
[393] J.-Y. Potvin, G. Lapalme and J.-M. Rousseau, ALTO: a computer system for the design of vehicle routing algorithms, Computers and Operations Research 16(1989)451.
[394] J.-Y. Potvin, G. Lapalme and J.-M. Rousseau, A generalized K-opt exchange procedure for the MTSP, INFOR 27(1989)474.
[395] J.-Y. Potvin and J.-M. Rousseau, A parallel route building algorithm for the vehicle routing and scheduling problem with time windows, European Journal of Operational Research 66(1993)331.
[396] H.N. Psaraftis, A dynamic programming solution to the single-vehicle, many-to-many immediate request dial-a-ride problem, Transportation Science 14(1980)130.
[397] H.N. Psaraftis, K-interchange procedures for local search in a precedence constrained routing problem, European Journal of Operational Research 13(1983)391.
[398] H.N. Psaraftis, Scheduling large-scale advance-request dial-a-ride systems, American Journal of Mathematical and Management Sciences 6(1986)327.
[399] H.N. Psaraftis, M.M. Solomon, T.L. Magnanti and T.U. Kim, Routing and scheduling on a shoreline with release times, Management Science 36(1990)212.
[400] V.M. Pureza and P.M. França, Vehicle routing problems via tabu search metaheuristic, Publication CRT-747, Centre de recherche sur les transports, Montréal (1991).
[401] A. Raghavendra, T.S. Krishnakumar, R. Muralidhar, D. Sarvanan and B.G. Raghavendra, A practical heuristic for a large scale vehicle routing problem, European Journal of Operational Research 57(1992)32.
[402] T.K. Ralphs, On the mixed Chinese postman problem, Operations Research Letters 14 (1993)123.
[403] R. Ramesh and K.M. Brown, An efficient four-phase heuristic for the generalized orienteering problem, Computers and Operations Research 18(1991)151.
[404] R. Ramesh, Y. Yong-Seok and M.H. Karwan, An optimal algorithm for the orienteering tour problem, ORSA Journal on Computing 4(1992)155.
[405] G. Reinelt, Fast heuristics for large geometric traveling salesman problems, ORSA Journal on Computing 4(1992)206.
[406] G. Reinelt, TSPLIB – A travelling salesman problem library, ORSA Journal on Computing 3(1991)376.
[407] J. Renaud, F.F. Boctor and G. Laporte, A fast composite heuristic for the symmetric traveling salesman problem, Publication #981, Centre de recherche sur les transports, Montréal (1994).

[408] J. Renaud, F.F. Boctor and G. Laporte, An improved petal heuristic for the vehicle routing problem, Journal of the Operational Research Society, forthcoming.

[409] J. Renaud, G. Laporte and F.F. Boctor, A tabu search heuristic for the multi-depot vehicle routing problem, Computers and Operations Research, forthcoming.

[410] C. Ribeiro and F. Soumis, A column generation approach to the multiple-depot vehicle scheduling problem, Operations Research 42(1994)41.

[411] L.J. Riccio, Management science in New York's Department of Sanitation, Interfaces (2) 14(1984)1.

[412] L.J. Riccio and A. Litke, Making a clean sweep; simulating the effects of illegally parked cars on New York's mechanical street cleaning efforts, Operations Research 34(1986)661.

[413] M.B. Richey and R.G. Parker, A cubic algorithm for the directed Eulerian subgraph problem, European Journal of Operations Research 50(1991)345.

[414] M.B. Richey, R.G. Parker and R.L. Rardin, On finding spanning Eulerian subgraphs, Naval Research Logistics Quarterly 32(1985)443.

[415] F. Robuste, C.F. Daganzo and R.R. Souleyrette, Implementing vehicle routing models, Transportation Research Part 24 (1990) 263.

[416] D. Ronen, Allocation of trips to trucks operating from a single terminal, Computers and Operations Research 19(1992)451.

[417] D. Ronen, Perspectives on practical aspects of truck routing and scheduling, European Journal of Operational Research 35(1988)137.

[418] Y. Rossier, M. Troyon and T.M. Liebling, Probabilistic exchange algorithms and the Euclidian traveling salesman problem, Operations Research Spektrum 8(1986)151.

[419] S. Roy and J.-M. Rousseau, The capacitated Canadian postman problem, INFOR 27(1989)58.

[420] S. Roy, J.-M. Rousseau, G. Lapalme and J.A. Ferland, Routing and scheduling for the transportation of disabled persons – the algorithm, Working Paper TP 5596E, Transport Canada, Transport Development Center, Montreal (1984).

[421] S. Roy, J.-M. Rousseau, G. Lapalme and J.A. Ferland, Routing and scheduling for the transportation of disabled persons – the tests, Working Paper TP 5598E, Transport Canada, Transport Development Center, Montreal (1984).

[422] R.A. Russell, Hybrid heuristics for the vehicle routing problem with time windows, Transportation Science 29(1995)156.

[423] R.A. Russell, An effective heuristic for the *M*-tour travelling salesman problem with some side conditions, Operations Research 25(1977)517.

[424] R.A. Russell and P.E. Chalinor, Effective methods for petroleum tank truck dispatching, Computers and Operations Research 15(1988)323.

[425] R.A. Russell and D. Gribbin, A multiphase approach to the period routing problem, Networks 21(1991)747–765.

[426] R.A. Russell and W. Igo, An assignment routing problem, Networks 9(1977)1.

[427] D.M. Ryan, C. Hjorring and F. Glover, Extension of the petal method for vehicle routing, Journal of the Operational Research Society 44(1993)289.

[428] S. Salhi and G.K. Rand, Improvements to vehicle routing heuristics, Journal of the Operational Research Society 38(1987)293.

[429] S. Salhi and G.K. Rand, The effect of ignoring routes when locating depots, European Journal of Operational Research 39(1989)150.

[430] S. Salhi and G.K. Rand, Incorporating vehicle routing into the vehicle fleet composition problem, European Journal of Operational Research 66(1993)313.
[431] S. Salhi, M. Sari and D. Sadi, Adaptation for some vehicle fleet mix heuristics, Omega 20(1992)653.
[432] J.M. Sanchis, El poliedro del problema del cartero rural, Ph.D.Thesis, Universidad de Valencia (1990).
[433] C. Sateesh and P.K. Ray, Vehicle routing in large organizations: A case study, International Journal of Operations and Production Management 12(1993)71.
[434] M.W.P. Savelsberg, The vehicle routing problem with time windows: Minimizing route duration, ORSA Journal on Computing 4(1992)146.
[435] M.W.P. Savelsbergh, An efficient implementation of local search algorithm for contrained routing problems, European Journal of Operational Research 47(1990)75.
[436] M.W.P. Savelsbergh, Computer aided routing, Ph.D. dissertation, Centre for Mathematics and Computer Science, Amsterdam, The Netherlands (1988).
[437] M.W.P. Savelsbergh, Local search in routing problems with time windows, Annals of Operations Research 4(1985)285.
[438] M.P.W. Savelsbergh and M. Sol, The general pickup and delivery problem, Transportation Science 29(1995)17.
[439] B. Schnetzler, Des opérateurs d'échange et une méthode de relaxation pour le problème du voyageur de commerce, RAIRO (Recherche opérationnelle) 26(1992)57.
[440] R. Séguin, Problèmes stochastiques de tournées de vehicules, Ph.D. Thesis, Université de Montréal (1993).
[441] F. Semet and L. Loewenton, The travelling salesman problem under accessibility constraints, INFOR, forthcoming.
[442] F. Semet and É. Taillard, Solving real-life VRP efficiently using tabu search, Annals of Operations Research 41(1993)469.
[443] M.L. Sena, Computer-aided dispatching (digital maps aid emergency response and fleet management), Computer Graphics World 13(1991)34.
[444] T. Sexton and L. Bodin, Optimizing single vehicle many-to-many operations with desired times: I. Scheduling, Transportation Science 19(1985)378.
[445] T. Sexton and L. Bodin, Optimizing single vehicle many-to-many operations with desired times: II. Routing, Transportation Science 19(1985)411.
[446] T. Sexton and Y. Choi, Pickup and delivery of partial loads with time windows, American Journal of Mathematical and Management Sciences 6(1986)369.
[447] D. Simchi-Levi, Hierarchical planning for probabilistic distribution-systems in Euclidean spaces, Management Science 38(1992)198.
[448] R.A. Skitt and R.R. Levary, Vehicle routing via column generation, European Journal of Operational Research 2 (1985)65.
[449] M. Sol and M.W.P. Savelsbergh, A branch-and-price algorithm for the pickup and delivery problem with time windows, COSOR 94-22, Department of Mathematics and Computer Science, Eindhoven University of Technology, The Netherlands (1994).
[450] M.M. Solomon, Algorithms for the vehicle routing and scheduling problems with time window constraints, Operations Research 35(1987)254.
[451] M.M. Solomon, On the worst-case a performance of some heuristics for the vehicle routing and scheduling problem with time window constraints, Networks 16(1986) 161.

[452] M.M. Solomon, E. Baker and J. Schaffer, Vehicle routing and scheduling problems with time window constraints: Efficient implementations of solution improvement procedures, in: *Vehicle Routing: Methods and Studies*, eds. B.L. Golden and A.A. Assad (North-Holland, Amsterdam, 1988).
[453] M.M. Solomon, A. Chalifour, J. Desrosiers and J. Boisvert, An application of vehicle-routing methodology to large-scale larvicide control programs, Interfaces 22(3) (1992)88.
[454] M.M. Solomon and J. Desrosiers, Time windows constraints routing and scheduling problems, Transportation Science 22(1988)1.
[455] B. Sørensen, Interactive distribution planning, Ph.D. Thesis, The Technical University of Denmark, Lyngby, Denmark (1986).
[456] R. Srivastava, Alternate solution procedures for the location-routing problem, Omega 2(1993)497.
[457] R. Srivastava and W.C. Benton, The location-routing problem: Considerations in physical distribution system design, Computers and Operations Research 17(1990)427.
[458] H. Stern and M. Dror, Routing electric meter readers, Computers and Operations Research 6(1979)209.
[459] W.R. Stewart and B.L. Golden, A Lagrangean relaxation heuristic for vehicle routing, European Journal of Operational Research 1 (1984)84.
[460] W.R. Stewart and B.L. Golden, Stochastic vehicle routing: A comprehensive approach, European Journal of Operational Research 14(1983)371.
[461] S.I.I. Su, The general postman problem, models and algorithms, Ph.D. Dissertation, Faculty of Graduate School, University of Maryland (1992).
[462] T. Sun, P. Meakin and T. Jossang, A fast optimization method based on a hierarchical strategy for the traveling salesman problem, Physica A199(1993)232.
[463] C. Sutcliffe and J. Board, Optimal solution of a vehicle-routeing problem: Transporting mentally handicapped adults to an adult training centre, Journal of the Operational Research Society 41(1990)61.
[464] A. Swersey and W. Ballard, Scheduling school buses, Management Science 30(1983)844.
[465] É. Taillard, Parallel iterative search methods for vehicle routing problems, Networks 23(1993)263.
[466] C.C.R. Tan and J.E. Beasley, A heuristic algorithm for the period vehicle routing problem, Omega 12(1984)497.
[467] R. Taylor, Vehicle routing: The Courage experience, Logistics Today 8(1989)19.
[468] S.R. Thangiah, Vehicle routing with time windows using genetic algorithms, Technical Report SRU-SpSc-TR-93-23, Slippery Rock University, Slippery Rock, PA (1993).
[469] S.R. Thangiah, K.E. Nygard and P.L. Juell, GIDEON: A genetic algorithm system for vehicle routing with time windows, in: *Proceedings Seventh IEEE Conference on Artificial Intelligence Applications*, IEEE Computer Society Press, Los Alamitos, CA (1991) p. 332.
[470] S.R. Thangiah, I.H. Osman and T. Sun, Metaheuristics for the vehicle routing problems with time windows, Working Paper UKC/IMS/OR94/4, Institute of Mathematics and Statistics, University of Kent, Canterbury, U.K. (1994).
[471] S.R. Thangiah, I.H. Osman, R. Vinayagamoorthy and T. Sun, Algorithms for the vehicle routing problems with time deadlines, American Journal of Mathematical and Management Sciences 13(1993)323.

[472] S.R. Thangiah, T. Sun and J.-Y. Potvin, Heuristic approaches to vehicle routing with backhauls and time windows, Report SRU-CpSc-TR-94-28, Computer Science Department, Slippery Rock University, PA (1994).

[473] P.M. Thompson, Local search algorithms for vehicle routing and other combinatorial problems, Ph.D. Thesis, Massachusetts Institute of Technology (1988).

[474] P.M. Thompson and H.N. Psaraftis, Cyclic transfer algorithms for the multi-vehicle routing and scheduling problems, Operations Research 41(1993)935.

[475] P. Toth and D. Vigo, An exact algorithm for the vehicle routing problem with backhauls, Research Report DEIS OR/93/5, University of Bologna, Italy (1993).

[476] T. Tsiligirides, Heuristic methods applied to orienteering, Journal of the Operational Research Society 35(1984)797.

[477] J. Tsitsiklis, Special cases of the traveling salesman and repairman problems with time windows, Networks 22(1992)263.

[478] W.B. Tucker and G.M. Clohan, Computer simulation of urban snow removal, Transportation Research Board Special Research Report No. 185 (1979) 293.

[479] N. Ulder, E. Aarts, H.J. Bandelt, P. van Laarhoven and E. Pesch, Genetic local search algorithms for the travelling salesman problem, eds. Schwefel and Manner, Lecture Notes in Computer Science 496(1991)109.

[480] G. Ulusoy, The fleet size and mix problem for capacitated arc routing, European Journal of Operational Research 22(1985)329.

[481] T. van Aardenne-Ehrenfest and N.G. de Bruijn, Circuits and trees in oriented linear graphs, Simon Stevin 28(1951)203.

[482] A. Van Breedam, Improvement heuristics for the vehicle routing problem based on simulated annealing, European Journal of Operational Research, forthcoming.

[483] L.J.J. Van der Bruggen, J.K. Lenstra and P.C. Schuur, Variable-depth search for the single vehicle pickup and delivery problem with time windows, Transportation Science 27(1993)298.

[484] H.R. van Landeghem, A bi-criteria heuristic for the vehicle routing problem with time windows, European Journal of Operational Research 36(1988)217.

[485] A. van Vliet, C. Boender, E. Guus and A.H.G. Rinnooy Kan, Interactive optimization of bulk sugar delivery, Interfaces 22(3) (1992) 4.

[486] D. Vigo, A heuristic algorithm for the asymmetric capacitated vehicle routing problem, *Applications Handbook of Genetic Algorithms: New Frontiers*, ed. L. Chambers, Volume 2 (CRG Press, Florida, 1995).

[487] B.F. Voigt, Der Handlungsreisende, wie er sein soll und was er zu tun hat, um Aufträge zu erhalten und eines glücklichen Erfolgs in seinen Geschäften gewiss zu sein, von einem alten Commis-Voyageur (Ilmenau, Verlag Bernd Schramm, Kiel, 1831), republished 1981.

[488] P. Wark and J. Holt, A repeated matching heuristic for the vehicle routeing problem, Journal of the Operational Research Society 4 (1994)1156.

[489] C.D.J. Waters, Interactive vehicle scheduling, Journal of the Operational Research Society 35(1984)821.

[490] C.D.J. Waters, Expert systems for vehicle scheduling, Journal of the Operational Research Society 41(1990)505.

[491] J.A.G. Willard, Vehicle routing usingr *r*-optimal tabu search, M.Sc. Dissertation, The Management School, Imperial College, London (1989).

[492] Z. Win, Contributions to routing problems, Doctoral Dissertation, Universität Augsburg (1987).
[493] Z. Win, On the windy postman problem on Eulerian graphs, Mathematical Programming 44(1989)97.
[494] R.T. Wong, Integer programming formulations of the traveling salesman problem, *Proceedings of the IEEE International Conference on Circuits and Computers* (1980) p. 149.
[495] K.F. Wong and J.E. Beasley, Vehicle routing using fixed delivery areas, Omega 12(1984)591.
[496] R.E.D. Woolsey, Being wrong with Clarke and Wright, Computers and Operations Research 18(1991)607.
[497] J. Wunderlich, M. Collette, L. Levy and L.D. Bodin, Scheduling meter readers for Southern California Gas Company, Interfaces 22(3) (1992) 22.
[498] C. Yano, T.J. Chan, L.K. Ritcher, T. Cutler, K.G. Murity and D. McGettigan, Vehicle routing at Quality Stores, Interfaces 17(2) (1987) 52.
[499] H. Zanakis, J.R. Evans and A. Vazacopoulos, Heuristic methods and applications: A categorized survey, European Journal of Operational Research 43(1989)88.
[500] E.L. Zielinski, Implementing a computerized vehicle routing system: A case study, Auerbach Reports 1, 24(1985)1.