An Extension of the Lin-Kernighan-Helsgaun TSP Solver for Constrained Traveling Salesman and Vehicle Routing Problems

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December 2017

Abstract

This report describes the implementation of an extension of the Lin-Kernighan-Helsgaun TSP solver for solving constrained traveling salesman and vehicle routing problems. The extension, which is called LKH-3, is able to solve a variety of well-known problems, including the sequential ordering problem (SOP), the traveling repairman problem (TRP), variants of the multiple travel-ing salesman problem (*m*TSP), as well as vehicle routing problems (VRPs) with capacity, time windows, pickup-and-delivery and distance constraints. The implementation of LKH-3 builds on the idea of transforming the problems into standard symmetric traveling from the literature has shown that LKH-3 is effective. Best known solutions are often obtained, and in some cases, new best solutions are found. The program is free of charge for academic and non-commercial use and can be downloaded in source code. A comprehensive library of bench-mark instances and the best obtained results for these instances can also be downloaded.

1. Introduction

The Lin-Kernighan-Helsgaun TSP solver, LKH [1, 2], is a state-of-the-art heuristic solver for the traveling salesman problem. LKH implements a powerful local search heuristic for the TSP based on the variable depth local search of Lin and Kernighan [3]. LKH has produced optimal solutions for all solved problems we have been able to obtain; including an 85,900-city instance (at the time of writ-ing, the largest nontrivial instance solved to optimality). Furthermore, the algorithm has improved the best known solutions for a series of large-scale instances with unknown optima, among these a 1,904,711-city instance (World TSP).

However, in many practical situations, the TSP has additional constraints such as limited resources, time windows and precedence constraints. Since the current version of LKH, LKH-2, is highly customized for the standard TSP and cannot accommodate constraints, its usage is extremely limited in these situations. Furthermore, solving problems that involve multiple traveling salesmen is not straightforward.

This is the motivation for extending LKH-2 with facilities handling constraints and multiple traveling salesmen. The extension, named LKH-3, is currently able to solve the following problem types:

ACVRP: Asymmetric capacitated vehicle routing problem
BWTSP: Black and white traveling salesman problem
CCVRP: Cumulative capacitated vehicle routing problem
CVRP: Capacitated vehicle routing problem
CVRPTW: Capacitated vehicle routing problem with time windows
DCVRP: Distance constrained capacitated vehicle routing problem
1-PDTSP: One-commodity pickup-and-delivery traveling salesman problem
***m*-PDTSP**: Multi-commodity pickup-and-delivery traveling salesman problem
***m*1-PDTSP**: Multi-commodity one-to-one pickup-and-delivery traveling salesman problem
MTRP: Multiple traveling repairman problem
MTRPD: Multiple traveling repairman problem with distance constraints
***m*TSP**: Multiple traveling salesmen problem
OVRP: Open vehicle routing problem
PDPTW: Pickup-and-delivery problem with time windows
PDTSP: Pickup-and-delivery traveling salesman problem
PDTSPF: Pickup-and-delivery traveling salesman problem with FIFO loading
PDTSPL: Pickup-and-delivery traveling salesman problem with LIFO loading
RCTVRP: Risk-constrained cash-in-transit vehicle routing problem
RCTVRPTW: Risk-constrained cash-in-transit vehicle routing with time windows
SOP: Sequential ordering problem
TRP: Traveling repairman problem
TSPPD: Traveling salesman problem with pickups and deliveries
TSPTW: Traveling salesman problem with time windows
VRPB: Vehicle routing problem with backhauls
VRPBTW: Vehicle routing problem with backhauls and time windows
VRPMPD: Vehicle routing problem with mixed pickup and delivery
VRPMPDTW: Vehicle routing problem with mixed pickup and delivery and time windows
VRPSPD: Vehicle routing problem with simultaneous pickup and delivery
VRPSPDTW: Vehicle routing problem with simultaneous pickup-delivery and time windows

Extensive testing on benchmark instances from the literature has shown that LKH-3 is effective. Best known solutions are often obtained, and in some cases, new best solutions are found.

The next sections describe the implementation of LKH-3.

2. Basic ideas

2.1 Transformations

An asymmetric problem with n cities is transformed into a symmetric problem with $2n$ cities using the transformation method of Jonker and Volgenant [4]. This transformation method is already implemented in LKH-2 and has been very successful for solving ATSP [5]. Note in this connection that some of the problems to be solved by LKH-3 are best conceived as asymmetric problems, even if the costs are symmetric. This is for example the case for problems with time windows. These problems are first transformed by LKH-3 to asymmetric problems before they are transformed to symmetric problems. A positive side effect of this approach is that LKH-3 is able to solve asymmetric versions of these problem types.

A vehicle routing problem usually involves more than one vehicle and may therefore be conceived as a multiple traveling salesman problem. Fortunately, a multiple traveling salesman problem with a single home city (depot) can easily be transformed to a standard traveling salesman problem [6]. A symmetric TSP with m salesmen can be solved using a symmetric TSP augmented with m - 1 copies of the home city, where infinite costs are assigned between home cities [7]. For those symmetric problems that are not transformed to asymmetric problems, LKH-3 uses the improved transformation by Jonker and Volgenant [8].

2.2 Penalty functions

LKH-3 uses penalty functions for handling constraints. A penalty function returns a value that depends on how much the given constraints are violated. In contrast to the traditional usage of penalty functions, where a penalty value is added to (or multiplied with) the objective value, these two values are kept separate by LKH-3. Associated with each tour is a pair (P, C), where P is the penalty of the tour, and C is its cost. Let T_1 and T_2 be two tours with associated pairs (P_1, C_1) and (P_2, C_2). Then T_1 is *better* than T_2 if $(P_1 < P_2) \vee (P_1 = P_2 \wedge C_1 < C_2)$. In other words: minimizing penalty is the primary objective, whereas minimizing cost is the secondary. A penalty function has been implemented for each problem type.

When a move on a given tour produces a better, the move is said to be *improving*. To check that a move is improving, the move is made, and the penalty and cost for the resulting tour are computed and compared with the penalty and cost of the original tour. If no improvement is found, the move is retracted.

2.3 Special moves

The data structure used in LKH for tour representation, a two-level tree [9], gives an average time complexity of $O(\sqrt{N})$ for making a move, where N is the number of cities. The average time complexity for move retraction is the same since this is performed by an inverted move.

The most time-consuming part of the move checking procedure is the penalty computation. Its worst-case time complexity is $O(N)$. Speedup may often be achieved by using the fact that the computation may be terminated as soon as the value becomes greater than the value for the current best tour. Some speedup might also be achieved by starting the computation in the route that most recently caused the computation to terminate However, worst-case time complexity is still $O(N)$.

The time complexity of the penalty computation necessitates that the number of moves to be checked should be small. The advanced high-order move types available in LKH can be used, but they will often be too time consuming. Therefore, a new specially designed 5-opt move generator is provided. Compared with the 5-opt move generator in LKH-2, the new generator mainly considers moves that do not reverse a segment on the tour. Furthermore, it adds a restricted exploration of sequential 4- and 5-opt moves as well as non-sequential 4- and 6-opt moves. In this way, the number of moves to consider is reduced considerably. Note that restricting the move search in this way has no consequence for asymmetric problem instances since moves that reverse a segment are forbidden anyway.

3. Input

LKH-3 includes code for reading problem instances and for printing solutions. Input is given in two separate files:

(1) a *problem file* and
(2) a *parameter file*

3.1 The problem file

The problem file contains a specification of the problem instance to be solved. The file format is an extension of the TSPLIB format [10]. A problem file consists of a *specification part* and of a *data part*. The specification part contains information on the file format and on its contents. The data part contains explicit data.

3.1.1 The specification part

All entries in this section are of the form <keyword> : <value>, where <keyword> denotes an alphanumerical keyword and <value> denotes alphanumerical or numerical data. Below is given a list of the new keywords in LKH-3:

SALESMEN : <*integer*>
Specifies the number of salesmen (= vehicles).

VEHICLES : <*integer*>
Specifies the number of vehicles (= salesmen).

DISTANCE : <*real*>
The maximum length allowed for each route in a vehicle route problem.

RISK_THRESHOLD : <*integer*>
The maximum risk allowed for each route in a risk constrained problem.

SCALE : <*integer*>
A scale factor for Euclidean instances. Distances are multiplied by this factor.

Note that the keyword CAPACITY, which is used for specifying the vehicle capacity, belongs to the original version of the TSPLIB format.

New distance functions have also been added:

EXACT_2D, EXACT_3D:
Euclidean distance multiplied by 1000 and rounded to nearest integer.

FLOOR_2D, FLOOR_3D:
Euclidean distance rounded down to the last integer.

TOR_2D, TOR_3D:
Toroidal distance.

3.1.2 The data part

Depending on the choice of specifications, some additional data may be required. These data are given in corresponding data sections following the specification part. Each data section begins with the corresponding keyword. The length of the section is either implicitly known from the format specification, or the section is terminated by an appropriate endof-section identifier.

LKH-3 extends the TSPLIB format with the following data sections:

BACKHAUL_SECTION :
This section is used for specifying VRPB instances. It contains a list of backhaul nodes. This section is terminated by a -1.

PICKUP_AND_DELIVERY_SECTION :
This section is used for specifying pickup-and-delivery instances. Each line is of the form

<integer> <integer> <real> <real> <real> <integer> <integer>

The first integer gives the number of the node.
The second integer gives its demand (ignored for PDTSPF, PDTSPL, VRPMPD and VRPSPD instances).
The third and fourth number give the earliest and latest time for the node.
The fifth number specifies the service time for the node.
The last two integers are used to specify pickup and delivery. For a PDPTW, PDTSP, PDTSPF and PDTSPL instance, the first of these integers gives the index of the pickup sibling, and the second integer gives the index of the delivery sibling. For a VRPMPD and VRPSPD instance, the two integers simply give the size of the pickup and delivery for the node.

SERVICE_TIME_SECTION :
The service times of all nodes of a CVRP are given in the form (per line)

<integer> <real>

The integer specifies a node number, the real its service time. The depot node must also occur in this section. Its service time is 0.

TIME_WINDOW_SECTION :
Time windows are given in this section. Each line is of the form

<integer> <real> <real>

The first integer specifies a node number. The two reals specify earliest and latest arrival time for the node, respectively.

The keyword DEPOT_SECTION, which is used for specifying depots, belongs to the original version of the TSPLIB format. The section is terminated by a -1. Note, however, that LKH-3 at present only allows one depot.

3.2 The parameter file

The parameter file contains control parameters for the solution process. The solution process is typically carried out using default values for the parameters. The default values have proven to be adequate in many applications. However, for applications with penalty functions, better performance is achieved by choosing other values. For such applications, experiments have shown that the following setting works well:

MOVE_TYPE = 5 SPECIAL
GAIN23 = NO
KICKS = 1
KICKTYPE = 4
MAX_SWAPS = 0
POPULATION_SIZE = 10

The specially designed 5-opt move procedure is chosen by setting MOVE_TYPE to 5 SPECIAL.

By setting GAIN23 to NO, the exploration of non-sequential moves at the end of each trial is turned off. Notice, however, that some non-sequential moves after all are explored by the chosen move procedure.

The default perturbation method in LKH is a random walk on the candidate graph. But this method destroys the tour a lot. Instead, by setting KICKS to 1 and KICK_TYPE to 4, a random double-bridge-kick move is chosen. This move is a non-sequential 4-opt move that replaces only 4 edges on the tour by 4 non-tour edges.

By setting MAX_SWAPS to 0, no attempts are made to find improving moves of a higher order than specified by the basic move type (5 SPECIAL).

The genetic algorithm of LKH with a population size of 10 is used.

The parameter settings above may be chosen by just writing

SPECIAL

in the beginning of the parameter file.

LKH-3 adds the following new or extended parameter settings:

BWTSP = <*integer*> <*integer*> [<*integer*>]
Specifies the three parameters (B, Q, L) to a BWTSP instance.
  B: Number of black nodes.
  Q: Maximum number of white nodes on "black-to-black" paths.
  L: Maximum length of any "black-to-black" path.
Default: 0 0.

DEPOT = <*integer*>
Specifies the depot node.
Default: 1.

INITIAL_TOUR_ALGORITHM = { … | CVRP | MTSP | SOP }
Specifies the algorithm for obtaining an initial tour.
Default: WALK.

MAKESPAN = { YES | NO }
Specifies if makespan optimization is to be used for a TSPTW instance.
Default: NO.

MOVE_TYPE = <*integer*> [SPECIAL]
Specifies the move type to be used in local search. An integer value k >= 2 signifies that a sequential k-opt move is to be used. The specifier SPECIAL can be given in order to use specially designed moves. For this type of moves, k must be 3 or 5.
Default: 5.

MTSP_MIN_SIZE = <i*nteger*>
Specifies the minimum number of cities each salesman must visit in an mTSP or CVRP instance. If negative, its value is set to
  DIMENSION / (ceil(1.0 * DIMENSION / MTSP_MAX_SIZE) + 1)
Default: 1.

MTSP_MAX_SIZE = <*integer*>
Specifies the maximum number of cities each salesman may visit in an mTSP or CVRP instance.
Default: value of DIMENSION - 1.

MTSP_OBJECTIVE = [MINMAX | MINMAX_SIZE | MINSUM]
Specifies the objective function type for a multiple traveling salesman problem.
  MINMAX - Minimize the length of the longest route.
  MINMAX_SIZE - Minimize the size of the largest route.
  MINSUM - Minimize the length of the overall tour.
All routes must satisfy the MTSP_MIN_SIZE and MTSP_MAX_SIZE constraints.

MTSP_SOLUTION_FILE = <*string*>
Specifies the name of a file where the solution of an *m*TSP (or VRP) instance is to be written.

SALESMEN = <*intege*r>
Specifies the number of salesmen/vehicles.
Default: 1.

SCALE = <*integer*>
Scale factor for Euclidean instances.
Default: 1.

SINTEF_SOLUTION_FILE = <*string*>
Specifies the name of a file where the solution of an *m*TSP or VRP instance is to be written.
The solution is written in SINTEF format.

VEHICLES = <*integer*>
Specifies the number of vehicles/salesmen.
Default: 1.

4. Summary of benchmark tests

LKH-3 has been tested extensively on benchmark instances from the literature. The table below summarizes the results. The first two columns give the problem type and number of test instances for this type. The three last columns give the number of times the solution found by LKH-3 was better than, equal to, or worse than the best known solution (BKS).

Problem type	Instances	< BKS	= BKS	> BKS
ACVRP	32	0	32	0
BWTSP	38	0	38	0
CCVRP	164	**53**	74	37
CVRP	509	**44**	327	138
CVRPTW	405	**2**	302	101
DCVRP	22	**1**	17	4
1-PDTSP	2036	**380**	1528	78
m-PDTSP	892	**118**	724	50
*m*1-PDTSP	1178	**21**	1157	0
*m*TSP	127	**51**	72	4
MTRP	1040	**7**	1033	0
MTRPD	180	0	180	0
OVRP	111	**4**	101	6
PDPTW	222	**3**	180	139
PDTSP	163	**5**	156	2
PDTSPF	77	**2**	47	28
PDTSPL	126	**15**	97	14
RCTVRP	378	**79**	283	16
RCTVRPTW	24	0	24	0
SOP	163	**9**	150	4
TRP	130	**21**	109	0
TSPPD	600	0	600	0
TSPTW	900	**47**	853	0
VRPB	149	**4**	141	4
VRPBTW	15	**3**	12	0
VRPMPD	70	**9**	55	6
VRPMPDTW	70	**9**	53	8
VRPSPD	266	**20**	148	98
VRPSPDTW	68	**46**	20	2

5. Conclusions

LKH-3 is based on the simple idea of transforming the problems to standard traveling salesman problems and handling the involved constraints by means of penalty functions. Despite its simplicity, extensive testing on benchmark instances from the literature has shown that LKH-3 is effective for solving a variety of problem types. Best known solutions are often obtained, and in some cases, new best solutions are found.

The program is free of charge for academic and non-commercial use and can be downloaded in source code via http://webhotel4.ruc.dk/~keld/research/LKH-3. A comprehensive library of test instances (about 10,000) and the best solutions obtained by LKH-3 for these instances can also be downloaded. A comparison with the best known solutions are given in tables.

References

[1] Helsgaun, K.:
An Effective Implementation of the Lin-Kernighan Traveling Salesman Heuristic.
Eur. J. Oper. Res., 126(1):106-130 (2000)

[2] Helsgaun, K.:
General k-opt submoves for the Lin-Kernighan TSP heuristic.
Math. Prog. Comput., 1(2-3):119-163 (2009)

[3] Lin. S., Kernighan, B. W.:
An Effective Heuristic Algorithm for the Traveling-Salesman Problem.
Oper. Res. 21, 498-516 (1973)

[4] Bektas, T.:
The multiple traveling salesman problem: an overview of formulations and solution procedures.
Omega, 34(3):209-219 (2006)

[5] Johnson D.S., Gutin G., McGeoch L.A., Yeo A., Zhang W., Zverovitch A.: *Experimental Analysis of Heuristics for the ATSP*.
In: Gutin G., Punnen A.P. (eds.): The Traveling Salesman Problem and Its Variations. Combinatorial Optimization, vol. 12. Springer, Boston, MA (2007)

[6] Rao, M. R.:
A note on the multiple traveling salesman problem.
Oper. Res., 28(3):628–32 (1980)

[7] Jonker, R., Volgenant, T.:
Technical Note - An Improved Transformation of the Symmetric Multiple Traveling Salesman Problem.
Oper. Res., 36(1):163-167 (1988)

[8] Jonker, R., Volgenant, T.:
Transforming asymmetric into symmetric traveling salesman problems.
Oper. Res. Let., 2:161-163 (1983)

[9] Fredman, M. L., Johnson, D. S., McGeoch, L. A.:
Data Structures for Traveling Salesmen.
J. Algorithms, 16:432-479 (1995)

[10] Reinelt, G.:
TSPLIB - A Traveling Salesman Problem Library.
ORSA J. Comput., 3(4):376-385 (1991)

Problem-specific literature

ACVRP: Asymmetric capacitated vehicle routing problem

Batsyn, M., Goldengorin, B., Kocheturov, A., Pardalos, P. M.:
Tolerance-Based vs. Cost-Based Branching for the Asymmetric Capacitated Vehicle Routing Problem.
In: Proceedings of the Second International Conference on Network Analysis:1-10 (2013)

Fischetti, M., Toth, P., Vigo, D.,
A Branch-And-Bound Algorithm for the Capacitated Vehicle Routing Problem on Directed Graphs.
Oper. Res., 42(5):846-859 (1994)

Leggieri, V., Haouari, M.:
A matheuristic for the asymmetric capacitated vehicle routing problem.
Discrete Appl. Math., Available online 6 May (2016)

Vigo, D.:
A Heuristic Algorithm for the Asymmetric Capacitated Vehicle Routing Problem.
Eur. J. Oper. Res., 89(1):108-126 (1996)

BWTSP: Black and white traveling salesman problem

Bhattacharya, B.., Hu, Y., Kononov, A.:
Approximation Algorithms for the Black and White Traveling Salesman Problem.
Lecture Notes in Computer Science, 4598:493-503 (2007)

Bourgeois, M., Laporte, G., Semet, F.:
Heuristics for the black and white traveling salesman problem.
Comput. Oper. Res., 30(1):75-85 (2003)

Ghiani, G., Laporte, G., Semet, F.:
The Black and White Traveling Salesman Problem.
Oper. Res., 54(2): 366-378 (2006)

Gouveia, L., Leitner, M., Ruthmair, M.:
Extended formulations and branch-and-cut algorithms for the Black-and-White Traveling Salesman Problem.
Eur. J. Oper. Res., 262(3):908-928 (2017)

Li, H., Alidaee, B.:
Tabu search for solving the black-and-white travelling salesman problem.
J. Oper. Res. Soc., 67(8):1061-1078.

Muter, I.:
A new formulation and approach for the black and white traveling salesman problem.
Comput. Oper. Res., 53: 96-106 (2015)

1-PDTSP: One-commodity pickup-and-delivery traveling salesman problem

Erdoğan G., Laporte, G., Calvo, R. W.:
The One Commodity Pickup and Delivery Traveling Salesman Problem with Demand Intervals.
CIRRELT 46 (2013)

Guerine, M., Rossetiand, I., Plastino, A.:
Extending the hybridization of metaheuristics with data mining: Dealing with sequences.
Intell. Data Anal., 20(5):1133-1156 (2016)

Hernández-Pérez, H., Salazar-González, J-J.:
A branch-and-cut algorithm for a traveling salesman problem with pickup and delivery.
Discrete Appl. Math., 145(1):126-139 (2004)

Hernández-Pérez, H., Salazar-González, J-J.:
Heuristics for the One-Commodity Pickup-and-Delivery Traveling Salesman Problem.
Trans. Sci., 38(2):245-255 (2004)

Hernández-Pérez, H., Salazar-González, J-J.:
The One-commodity Pickup-and-Delivery Traveling Salesman Problem: Inequalities and Algorithms.
Networks, 50(4):258-272 (2007).

Hernández-Pérez, H., Rodríguez-Martín, I., Salazar-González, J-J.:
A hybrid GRASP/VND heuristic for the One-Commodity Pickup-and-Delivery Traveling Salesman Problem.
Comput. Oper. Res., 36(5):1639-1645 (2009)

Hosny, M. I., Mumford, C. L.:
Solving the One-Commodity Pickup and Delivery Problem Using an Adaptive Hybrid VNS/SA Approach.
J. Heu., 16 (3):417-439 (2010)

Luong, B. T.:
One commodity pickup and delivery traveling salesman problem and an extension formulations and algorithms.
MSc thesis, Purdue University (2011)

Mladenovic N., Uroševic, D., Hanafi, S., Ilic A.:
A general variable neighborhood search for the one-commodity pickup-and-delivery travelling salesman problem.
Eur. J. Oper. Res., 220(1):270-285 (2012)

Mosheiov, G.,
The travelling salesman problem with pick-up and delivery.
Eur. J. Oper. Res., 79(2):299-310 (1994)

Ren, L., Duhamel, C., Quilliot, A.:
A hybrid ILS/VND heuristic for the One-Commodity Pickup-and-Delivery Traveling Salesman Problem.
In: Proceedings of International Workshop on Green Supply Chain, GSC (2012).

Yahyaoui, H., Tlili, T., Krichen, S.:
A Randomized Multi-start Genetic Algorithm for the One-Commodity Pickup-and-Delivery Traveling Salesman Problem.
In: Advances in Swarm and Computational Intelligence, LNCS 9142:4549 (2015)

F. Zhao, F., Li, S., Sun, J., Mei, D.:
*Genetic algorithm for the one-commodity pickup-and-delivery traveling salesman pr*oblem.
Comput. Ind. Eng., 56(4):16421648 (2009)

CCVRP: Cumulative capacitated vehicle routing problem

Ke, L., Feng, Z.:
A two-phase metaheuristic for the cumulative capacitated vehicle routing problem.
Comput. Oper. Res., 40(2):633-638 (2013)

Lysgaard, J., Wøhlk, S.:
A branch-and-cut-and-price algorithm for the cumulative capacitated vehicle routing problem.
Eur. J. Oper. Res., 236(3):800-810 (2014)

Ngueveu, S. U., Prins, C., Calvo, R. W.:
An effective memetic algorithm for the cumulative capacitated vehicle routing problem.
Comput. Oper. Res., 37(11):1877-1885 (2010)

Ribeiro, M. R, Laporte, G.:
An adaptive large neighborhood search heuristic for the cumulative capacitated vehicle routing problem.
Comput. Oper. Res., 39(3):728-735 (2012)

Sze. J. F, Salhi, S, Wassan, N.:
The cumulative capacitated vehicle routing problem with min-sum and min-max objectives: An effective hybridisation of adaptive variable neighbourhood search and large neighbourhood search.
Transp. Res., Part B, 101:162-184 (2017)

CVRP: Capacitated vehicle routing problem

Alba, E., Dorronsoro, B.:
A Hybrid Cellular Genetic Algorithm for the Capacitated Vehicle Routing Problem.
In: Engineering Evolutionary Intelligent Systems:379-422 (2008)

Augerat, P., Belenguer, J. M., Benavent, E., Corberin, A., Naddef, D.:
Separating capacity constraints in the CVRP using tabu search.
Eur. J. Oper. Res., 106(2-3):546-557 (1998)

Beasly, J E.:
Route first--Cluster second methods for vehicle routing.
Omega, 11(4):403-408 (1983)

Bjarnadóttir, A. S.:
Solving the Vehicle Routing Problem with Genetic Algorithms.
MSc thesis, Technical University of Denmark (2004)

Brajevic, I.:
Artificial bee colony algorithm for the capacitated vehicle routing problem.
In: Proceedings of the European Computing Conference 2011:239-244 (2011)

Bräysy, O.:
Fast Local Searches For The Vehicle Routing Problem With Time Windows.
INFOR, 40(4):319-330 (2002)

Breedam, A. V.:
An Analysis of the Behavior of Heuristics for the Vehicle Routing Problem for a selection of problems with Vehicle-related, Customer-related, and Time-related Constraints.
PhD thesis, University of Antwerp (1994)

Breedam, A. V.,
Comparing descent heuristics and metaheuristics for the vehicle routing problem.
Comput. Oper. Res., 28(4):289-315 (2001)

Breedam, A. V.:
A parametric analysis of heuristics for the vehicle routing problem with side-constraints.
Eur. J. Oper. Res., 137(2):348-370 (2002)
Chen, P., Huang, H., Dong, X.:
Iterated variable neighborhood descent algorithm for the capacitated vehicle routing problem.
Expert Syst. Appl., 37(2):1620-1627 (2010)

Christofides, N., Eilon, S.:
An algorithm for the vehicle-dispatching problem.
Oper. Res. Quart., 20:309–318 (1969)

Christofides, N., Mingozzi, A., Toth, P.:
The vehicle routing problem.
In Christofides, N., Mingozzi, A., Toth, P., Sandi, C. (Eds.):
Combinatorial optimization: vol. 1, pp. 315–338, (1979).

Cordeau, J-F., Gendreau, M., Hertz, A., Laporte, G., Sormany, J-S.:
New Heuristics for the Vehicle Routing Problem.
In: Logistics Systems: Design and Optimization:279-297 (2004)

Dorronsoro, B., Aria, D., Luna, F., Nebro, A. J., Alba, E.:
A grid-based hybrid cellular genetic algorithm for very large scale instances of the CVRP.
In: Proceedings 21st European Conference on Modelling and Simulation:759-765 (2007)

Fan, Z., Tu, W., Li, Q., Shaw, S-L., Chen, S., Chen, B. Y.:
A Voronoi neighborhood-based search heuristic for distance/capacity constrained very large vehicle routing problems.
Int. J. Geogr. Inf. Sci., 27(4):741-764 (2013)

Fischetti, M., Toth, P.:
A new ILP-based refinement heuristic for Vehicle Routing Problems.
Math. Prog., 105(2):471-499 (2006)

Fisher, M. L., Jaikumar, R.:
A generalized assignment heuristic for vehicle routing.
Networks, 11(3): 109-124 (1981)

Fosin, J., Caric, T., Ivanjko, E.:
Vehicle Routing Optimization Using Multiple Local Search Improvements.
Automatika, 55(2):124-132 (2014)

Frutos, M., Tohmé, F.:
A New Approach to the Optimization of the CVRP through Genetic Algorithms.
AJOR, 2(4):495-501 (2012)

Fukasawa, R., Longo, H., Lysgaard, J., Aragäo, M. P. de, Reis, M., Uchoa, E., Werneck, R.F.:
Robust Branch-and-Cut-and-Price for the Capacitated Vehicle Routing Problem.
Math. Prog., Ser. A, 106:491511 (2006)

Funke, B., Grünert, T., Irnich, S.:
Local Search for Vehicle Routing and Scheduling Problems: Review and Conceptual Integration.
J. Heu., 11(4):267306 (2005)

Gendreau, M., Hertz, A., Laporte, G.:
A Tabu Search Heuristic for the Vehicle Routing Problem.
Manage. Sci., 40(10):1276-1290 (1994)

Golden, B. L., Wasil, E. A., Kelly, J. P., Chao, I-M.:
The Impact of Metaheuristics on Solving the Vehicle Routing Problem: Algorithms, Problem Sets, and Computational Results.
In: Fleet Management and Logistics (T. G. Crainic. T. G. Laporte, G., eds.).
Kluwer Academic, Boston, pp. 33–56 (1998)

Golden, B. L, Magnanti, T. L., Nguen, H. Q.:
Implementing vehicle routing algorithms.
Networks, 7(2):113-148 (1977)

Gröer, C.:
Parallel and serial algorithms for vehicle routing problems.
PhD thesis, University of Maryland (2008)

Gröer, C., Golden, B., Wasil, E.:
A library of local search heuristics for the vehicle routing problem.
Math. Prog. Comput., 2(2):79101 (2010)

Guimarans, D., Herrero, R., Riera, D., Juan, A. A., Ramos, J. J.:
Combining probabilistic algorithms, Constraint Programming and Lagrangian Relaxation to solve the Vehicle Routing Problem.
Ann. Math. Artific. Intell., 62(3-4):299315 (2011)

Guimarans, D., Herrero, R., Riera, D., Juan, A.A, J. J. Ramos, J. J.:
Solving Vehicle Routing Problems Using Constraint Programming and Lagrangean Relaxation in a Metaheuristics Framework.
IJISSCM, 4(2):61-81 (2011)

Hasle, G., Kloster, O.;
Industrial Vehicle Routing.
In: Geometric Modelling, Numerical Simulation, and Optimization: Applied Mathematics at SINTEF (2007)

Irnich, S., Funke, B., Grünert, T.:
Sequential search and its application to vehicle-routing problems.
Comput. Oper. Res., 33(8):24052429 (2005)

Irnich, S.:
A Unified Modeling and Solution Framework for Vehicle Routing and Local Search-Based Metaheuristics.
INFORMS J. Comput., 20(2):270-287 (2008)

Jin, J., Crainic, T. G., Løkketangen, A.:
A Cooperative Parallel Metaheuristic for the Capacitated Vehicle Routing Problem.
Comput. Oper. Res., 44:33-41 (2014)

Juan, A. A., Faulin, J., Jorba, J., Barrios, B.:
SR-2: A Hybrid Algorithm for the Capacitated Vehicle Routing Problem.
Faculty Research & Creative Works, Paper 586 (2008)

Juan, A. A., Faulin, J., Ruiz, R., Barrios, B., Caballé, S.:
The SR-GCWS hybrid algorithm for solving the capacitated vehicle routing Problem.
Appl. Soft Comput., 10(1):215224 (2010)

Kindervater, G. A. P., Savelsbergh, M. W. P.:
Vehicle Routing 2: Handling Side Constraints.
Technical report, School of Industrial and Systems Eng., Georgia Institute of Tech. (1995)

Kubiak, M., Wesolek, P.:
Accelerating Local Search in a Memetic Algorithm for the Capacitated Vehicle Routing Problem.
In: EvoCOP 2007:99-107, 2007.

Kytöjoki, J., Nuortio, T., Bräysy, O., Gendreau, M.:
An efficient variable neighborhood search heuristic for very large scale vehicle routing problems.
Comput. Oper. Res., 34(3):2743-2757 (2007)

Laporte, G.:
The Vehicle Routing Problem: An overview of exact and approximate algorithms.
Eur. J. Oper. Res., 59(3): 345-358 (1992)

Laporte, G., Gendreau, M., Potvin, J-Y., Semet, F.:
Classical and modern heuristics for the vehicle routing problem.
Int. T. Oper. Res., 7(4-5):285-300 (2000)

Layeb, A., Ammi, M., Chikhi, S.:
A GRASP Algorithm Based on New Randomized Heuristic for Vehicle Routing Problem.
J. Comput. Inf. Tech., Volume 21(1), pp. 35-46, 2013.

Li, F., Golden B., Wasil, E.:
Very large-scale vehicle routing: new test problems, algorithms, and results.
Comput. Oper. Res., 32(5):1165-1179 (2005)

Liu, W., Li, X.:
A Problem-Reduction Evolutionary Algorithm for Solving the Capacitated Vehicle Routing Problem.
Math. Prob. Eng., Article ID 165476, 11 pages, 2015.

Marinakis, Y., Marinaki, M., Dounias, G.:
Honey Bees Mating Optimization algorithm for large scale vehicle routing problems.
Nat. Comput., 9(1):527 (2010)

Naddef, D., Rinaldi, G.;
Branch and cut algorithms for the vehicle routing problem.
Istituto di analisi dei sistemi ed informatica, R. 515 (1999)

Nagata, Y., Bräysy, O.:
Edge Assembly-Based Memetic Algorithm for the Capacitated Vehicle Routing Problem.
Networks, 54(4):205-215 (2009)

Niu, Y., Wang, S., He, J., Xiao, X.:
A novel membrane algorithm for capacitated vehicle routing problem.
Soft Comput., 19(2):471482 (2015)

Pecin, D., Pessoa, A., Poggi, M., Uchoa, E.:
Improved branch-cut-and-price for capacitated vehicle routing.
Math. Prog. Comput., 9(1):61100 (2017)

Perboli, G., Pezzellam, F., R. Tadei, R.:
EVE-OPT: a hybrid algorithm for the capacitated vehicle routing problem.
Math. Method. Oper. Res., 68(2):361382 (2008)

Pessoa, A., Aragão, M. P. De, Uchoa, E.:
Robust Branch-Cut-and-Price Algorithms for Vehicle Routing Problems.
In: The vehicle routing problem: Latest advances and new challenges: 297-325 (2008)

Pisinger, D., Ropke, S.:
A general heuristic for vehicle routing problems.
Comput. Oper. Res., 34(8):2403-2435 (2005)

Pornsing, C.;
A particle swarm optimization for the vehicle routing problem with simultaneous pickup and delivery.
Comput. Oper. Res., 36(5):1693-1702 (2009)

Qi, C.:
Vehicle Routing Optimization in Logistics Distribution using Hybrid Ant Colony Algorithm.
TELKOMNIKA, 11(9):5308~5315 (2013)

Qi, C., Li, P.:
An Exponential Entropy-based Hybrid Ant Colony Algorithm for Vehicle Routing Optimization.
Appl. Math. Inf. Sci., 8(6):3167-3173 (2014)

Qui, S.:
Airline crew pairing optimization problems and capacitated vehicle routing problems.
PhD thesis, Georgia Institute of Technology (2013)

Ralphs, T., Kopman, L., Pulleyblank, W., Trotter, L. E.:
On the Capacitated Vehicle Routing Problem.
Math. Prog., 94(2):343-359 (2003)

Roberti, R.:
Exact Algorithms for Different Classes of Vehicle Routing Problems.
PhD thesis, University of Bologna (2012)

Rochat, Y., Taillard, É. D.:
Probabilistic diversification and intensification in local search for vehicle routing.
J. Heur., 1(1): 147-167 (1995)

Ropke, S.:
Heuristic and exact algorithms for vehicle routing problems.
PhD thesis, Technical University of Denmark (2005)

S. Ropke,
Parallel large neighborhood search - a software framework.
The VIII Metaheuristics International Conference (2009)

Ruttanateerawichien, K., Kurutach, W.:
An Improved Golden Ball Algorithm for the Capacitated Vehicle Routing Problem.
In: Bio-Inspired Computing - Theories and Applications:341-356 (2014)

Shin, K., Han, S.:
A Centroid-based Heuristic Algorithm for the Capacitated Vehicle Routing Problem.
Comput. Inf., 30(4):721732 (2011)

Snoeys, C.:
Comparison of Meta-heuristic Approaches for Large-scale Vehicle Routing Problems.
MSc thesis, Ghent University (2014)

Subramanian, S.:
Heuristic, Exact and Hybrid Approaches for Vehicle Routing Problems.
PhD thesis, Universidade Federal Fluminense (2012)

Subramanian, A., Uchoa, E., Ochi, L.S.:
A hybrid algorithm for a class of vehicle routing problems.
Comput. Oper. Res., 40(10):2519-2531 (2013)

Sze, J., F., Salhi, S., Wassan, N.:
A hybridisation of adaptive variable neighbourhood search and large neighbourhood search: Application to the vehicle routing problem.
Expert Syst. Appl., 65:383-397 (2016)

Szeto, W.Y., Wu, Y., Ho, S. C.:
An artificial bee colony algorithm for the capacitated vehicle routing problem.
Eur. J. Oper. Res, 215(1):126135 (2011)

Takes, F. W., Kosters, W. A.:
*Applying Monte Carlo Techniques to the Capacitated Vehicle Routing Pro*blem.
22th Benelux Conference on Artificial Intelligence (2010)

Teymourian, E., Kayvanfar, V., Komaki, GH. M., Zandieh, M.:
Enhanced Intelligent Water Drops and Cuckoo Search Algorithms for Solving the Capacitated Vehicle Routing Problem.
Inf. Sci., 334-335:354-378 (2016)

Toth, P., Tramontani, A.:
An Integer Linear Programming Local Search for Capacitated Vehicle Routing Problems.
In: The Vehicle Routing Problem: Latest Advances and New Challenges: 275-295 (2008)

Toth, P., Vigo, D.:
The Granular Tabu Search and Its Application to the Vehicle-Routing Problem.
INFORMS J. Comput., 15(4):333-346 (2003)

Uchoa, E., Pecin, D., Pessoa, A., Poggi, M., Vidal, T., Subramanian, A.:
New Benchmark Instances for the Capacitated Vehicle Routing Problem.
Eur. J. Oper. Research, 257(3):845-858 (2017)

Vigo, D.:
A Heuristic Algorithm for the Asymmetric Capacitated Vehicle Routing Problem.
Eur. J. Oper. Res., 89(1):108-126 (1996)

Volna, E., Kotyrba,M.:
Unconventional Heuristics for Vehicle Routing Problems.
J. Numer. Anal., Industrial and Applied Mathematics, 9-10(3-4):57-67 (2016)

Yousefikhoshbakht, Y., Khorram, E.:
Solving the vehicle routing problem by a hybrid meta-heuristic algorithm.
J. Ind. Eng. Int, 8(1), 11 pages, 2012.

Zachariadis, E. E., Kiranoudis, C. T.:
A Strategy for Reducing the Computational Complexity of Local Search-Based Methods, and its Application to the Vehicle Routing Problem.
Comput. Oper. Res., 37(12):2089-2105 (2010)

Zhou, Y., J. Xie, J., Zheng, H.;
A Hybrid Bat Algorithm with Path Relinking for Capacitated Vehicle Routing Problem.
Math. Prob. Eng., Article ID 392789, 10 pages (2013)

CVRPTW: Capacitated vehicle routing problem with time windows

Alvarenga, G. B., Mateus, G. R., Tomi, G. De:
Finding Near Optimal Solutions for Vehicle Routing Problems with Time Windows Using Hybrid Genetic Algorithm.
In: Proceedings of the Second International Workshop on Freight Transportation and Logistics (2003)

Bräysy, O., Gendreau, M.:
Vehicle Routing Problem with Time Windows, Part I: Route Construction and Local Search Algorithms.

Transp. Sci., 39(1):104-118 (2005)
Bräysy, O., Gendreau, M.:
Vehicle Routing Problem with Time Windows, Part II: Metaheuristics.
Transp. Sci., 39(1):119-139 (2005)

Cordeau, J-F., Desaulniers, G., Desrosiers, J., Solomon, M. M., Soumis, S.:
VRP with Time Windows.
In: The Vehicle Routing Problem:157-193 (2001)

Figliozzi, M.A.:
An Iterative Route Construction and Improvement Algorithm for the Vehicle Routing Problem with Soft and Hard Time Windows.
Transp. Res., Part C, Emerging Technologies, 18(5):668-679 (2010).

Gambardella, L. M., Taillard, E., Aggazzi, G.:
MACS-VRPTW: A multiple ant colony system for vehicle routing problems with time windows.
Technical report, Istituto Dalle Molle Di Studi Sull Intelligenza Artificiale (1999)

Gehring, H., Homberger, J.:
A parallel hybrid evolutionary metaheuristic for the vehicle routing problem with time windows.
In: Proceedings of EUROGEN99:57–64 (1999)

Gendreau, M., Tarantilis, C. D.:
Solving Large-Scale Vehicle Routing Problems with Time Windows: The State-of-the-Art.
CIRRELT-2010-04 (2010)

Jepsen, M., Spoorendonk, S., Petersen, B., Pisinger, D.,
A Non-Robust Branch-And-Cut-And-Price Algorithm for the Vehicle Routing Problem with Time Windows.
Technical Report no. 06/03, DIKU, University of Copenhagen (2003)

Jepsen, M.:
Branch-and-cut and Branch-and-Cut-and-Price Algorithms for Solving Vehicle Routing Problems.
PhD thesis, Technical University of Denmark (2011)

Kallehauge, B.:
On the vehicle routing problem with time windows.
PhD thesis, Technical University of Denmark (2006)

Kisjes, K.;
A Quantitative Comparison of Generalized Fast Construction Heuristics for the Vehicle Routing Problem with Time Windows.
MSc thesis, Erasmus University Rotterdam (2012)

Kohl, N., Madsen, O. B. G.:
An Optimization Algorithm for the Vehicle Routing Problem with Time Windows Based on Lagrangian Relaxation.
Oper. Res., 45(3):395-406 (1997)

Larsen, J.;
Vehicle Routing with Time Windows - Finding optimal solutions efficiently.
Technical report, Technical University of Denmark (1999)

Larsen, J.:
Parallelization of the Vehicle Routing Problem with Time Windows.
PhD thesis, Technical University of Denmark (2001)

Larsen, J.;
Speeding up the solution process for the Vehicle Routing Problem with Time Windows using structural information.
Technical report, Technical University of Denmark (2001)

Lau, H. C., Sim, M., Teo, K M.;
Vehicle routing problem with time windows and a limited number of vehicles.
Eur. J. Oper. Res., 148(3):559569 (2003)

Lysgaard, J.:
Reachability Cuts for the Vehicle Routing Problem with Time Windows.
Eur. J. Oper. Res., 175(1):210-223 (2006)

Mester, D, Bräysy, O.:
Active guided evolution strategies for large-scale vehicle routing problems with time windows.
Comput. Oper. Res., 32(6):15931614 (2005)

Minocha, B., Mohan, C.:
Solution of VRPTW using controlled random search technique.
In: Proceedings of the 3rd International Conference on Electronics: 203-208 (2011)

Nalepa, J., Czech, Z. J.:
A Parallel Memetic Algorithm to Solve the Vehicle Routing Problem with Time Windows.
Studia Informatica, 33(1): 91106 (2012)

Razavi, M., Eshlaghy, A. T.:
Using an Ant Colony approach for Solving capacitated Vehicle Routing Problem with time Windows.
R. J. Recent Sci., 4(2): 30-35 (2015)

Russell, R.:
Hybrid Heuristics for the Vehicle Routing Problem with Time Windows.
Transp. Sci., 29: 156-166 (1995)

Schulze, J., Fahle, T.:
A parallel algorithm for the vehicle routing problem with time window constraints.
Ann. Oper. Res., 86(0):585-607 (1999)

DCVRP: Distance constrained capacitated vehicle routing problem

Almoustafa, S.:
Distance-constrained vehicle routing problem: exact and approximate solution (mathematical programming).
PhD thesis, Brunel University (2013)

Almoustafa, S., Hanafi, S., Mladenović, N.:
New exact method for large asymmetric distance-constrained vehicle routing problem.
Eur. J. Oper. Res., 226(3):386-394 (2013)

Laporte, G., Desrochers, M., Nobert, Y.:
Two exact algorithms for the distance-constrained vehicle routing problem.
Networks, 14(1):161-172 (1984)

Laporte, G., Nobert, Y., Tailefer, S.:
A branch-and-bound algorithm for the asymmetrical distance-constrained vehicle routing problem.
Math. Model., 9(12):857-868 (1987)

Viswanath N., Ravi, R.:
Approximation algorithms for distance constrained vehicle routing problems.
Networks, 59(2):209-214 (2012)

Tlili, T., Faiz, Krichen, S.:
A Hybrid Metaheuristic for the Distance-constrained Capacitated Vehicle Routing Problem.
Procedia - Soc. Beh. Sci., 109:779-783 (2014)

1-PDTSP: One-commodity pickup-and-delivery traveling salesman problem

Erdoğan G., Laporte, G., Calvo, R. W.:
The One Commodity Pickup and Delivery Traveling Salesman Problem with Demand Intervals.
CIRRELT 46 (2013)

Guerine, M., Rossetiand, I., Plastino, A.:
Extending the Hybridization of Metaheuristics with Data Mining to a Broader Domain.
In: Proceedings of the 16th International Conference on Enterprise Information Systems, ICEIS: 395-406 (2014)

Guerine, M., Rossetiand, I., Plastino, A.:
Extending the hybridization of metaheuristics with data mining: Dealing with sequences.
Intell. Data Anal., 20(5):1133-1156 (2016)

Hernández-Pérez, H., Salazar-González, J-J.:
A branch-and-cut algorithm for a traveling salesman problem with pickup and delivery.
Discrete Appl. Math., 145(1):126-139 (2004)

Hernández-Pérez, H., Salazar-González, J-J.:
Heuristics for the One-Commodity Pickup-and-Delivery Traveling Salesman Problem.
Trans. Sci., 38(2):245-255 (2004)

Hernández-Pérez, H., Salazar-González, J-J.:
The One-commodity Pickup-and-Delivery Traveling Salesman Problem: Inequalities and Algorithms.
Networks, 50(4):258-272 (2007).

Hernández-Pérez, H., Rodríguez-Martín, I., Salazar-González, J-J.:
A hybrid GRASP/VND heuristic for the One-Commodity Pickup-and-Delivery Traveling Salesman Problem.
Comput. Oper. Res., 36(5):1639-1645 (2009)

Hosny, M. I., Mumford, C. L.:
Solving the One-Commodity Pickup and Delivery Problem Using an Adaptive Hybrid VNS/SA Approach.
J. Heu., 16 (3):417-439 (2010)

Luong, B. T.:
One commodity pickup and delivery traveling salesman problem and an extension formulations and algorithms.
MSc thesis, Purdue University (2011)

Mladenovic N., Uroševic, D., Hanafi, S., Ilic A.:
A general variable neighborhood search for the one-commodity pickup-and-delivery travelling salesman problem.
Eur. J. Oper. Res., 220(1):270-285 (2012)

Ren, L., Duhamel, C., Quilliot, A.:
A hybrid ILS/VND heuristic for the One-Commodity Pickup-and-Delivery Traveling Salesman Problem.
In: Proceedings of International Workshop on Green Supply Chain, GSC (2012).

Yahyaoui, H., Tlili, T., Krichen, S.:
A Randomized Multi-start Genetic Algorithm for the One-Commodity Pickup-and-Delivery Traveling Salesman Problem.
In: Advances in Swarm and Computational Intelligence, LNCS 9142:4549 (2015)

F. Zhao, F., Li, S., Sun, J., Mei, D.:
Genetic algorithm for the one-commodity pickup-and-delivery traveling salesman problem.
Comput. Ind. Eng., 56(4):16421648 (2009)

***m*-PDTSP**: Multi-commodity pickup-and-delivery traveling salesman problem

Eskildsen, C. B.:
A meta-heuristic for the multi-commodity Pickup-and-Delivery Traveling Salesman Problem.
MSc thesis, Aarhus University (2015)

Hernandez-Pérez, H., Rodríguez-Martín, I., Salazar-González, J-J.:
A hybrid heuristic approach for the multi-commodity pickup-and-delivery traveling salesman problem.
Eur. J. Oper. Res., 251(1):44-52 (2016)

Hernandez-Pérez, H., Salazar-González, J-J.:
The Multi-commodity Pickup-and-Delivery Traveling Salesman Problem.
Networks, 63(1):46-59 (2014)

***m*1-PDTSP**: Multi-commodity one-to-one pickup-and-delivery traveling salesman problem

Hernandez-Pérez, H., Salazar-González, J-J.:
The multi-commodity one-to-one pickup-and-delivery traveling salesman problem.
Eur. J. Oper. Res., 196(3): 987-995 (2009)

MTRP: Multiple traveling repairman problem

Onder, G.:
New formulations for multiple traveler minimum latency problem. [in Turkish]
Thesis, Baskent University (2015)

Onder, G., Kara, I., Derya, T.:
New integer programming formulation for multiple traveling repairmen problem.
Transp, Res. Proc., 22:355–361 (2017)

MTRPD: Multiple traveling repairman problem with distance constraints

Luo, Z., Qin, H., Lim, A.:
Branch-and-price-and-cut for the multiple traveling repairman problem with distance constraints.
Eur. J. Oper. Res., 234(1):49-60 (2014)

***m*TSP**: Multiple traveling salesmen problem

Applegate, D., Cook, W., Dash, S.; Rohe, A.:
Solution of a min-max vehicle routing problem.
INFORMS J. Comput., 14(2):132-143 (2002)

Baranwal, M., Roehl, B., Salapaka, S. M.:
A Deterministic Annealing Approach to the Multiple Traveling Salesmen and Related Problems.
arXiv:1604.04169 (2016)

Bektas, T.,
The multiple traveling salesman problem: an overview of formulations and solution procedures.
Omega, 34(3):209-219 (2004)

Bolaños, R. I., Toro, E. M. O., Granada, M. E.:
A population-based algorithm for the multi travelling salesman problem.
Int. Ind. Eng. Comput., 7(2):245-256 (2016)

Carter, E.,
Design and Application of Genetic Algorithms for the Multiple Traveling Salesperson Assignment Problem.
PhD thesis, Virginia Polytechnic Institute and State University (2003)

Carter E., and Ragsdale, C.:
A new approach to solving the multiple traveling salesperson problem using genetic algorithms.
Eur. J. Oper. Res., 175(1):246-257 (2006)

Chen, S. H.:
Minimization of the Total Traveling Distance and Maximum Distance by Using a Transformed-Based Encoding EDA to Solve the Multiple Traveling Salesmen Problem.
Math. Prob. Eng., Article ID 640231, 13 pages (2015)

Cornu, M., Cazenave, T., Vanderpooten, D.:
Perturbed Decomposition Algorithm applied to the multi-objective Traveling Salesman Problem.
Comput. Oper. Res., 79:314-330 (2017)

França, P.M., Gendreau, M., Laporte, G., Müller, F.:
The m-Traveling Salesman Problem with Minimax Objective.
Transp. Sci., 29(3):267-275 (1995)

Gavish, B., Srikanth, K.:
An Optimal Solution Method for Large-Scale Multiple Traveling Salesmen Problems.
Oper. Res., 34(5):698-717 (1986)

Golden, B. L., Laporte, G., Taillard, É. D.:
An Adaptive Memory Heuristic for a Class of Vehicle Routing Problems with Minmax Objective.
Comput. Oper. Res., 24(5):445-452 (1997)

GuoXing, Y.:
Transformation of Multi-Depot Multi-Salesmen Problem to the standard Traveling Salesman Problem.
Eur. J. Oper. Res., 81(3):557-560 (1995)

Hingrajiya, K. H., Gupta, R. K., Chandel, G. S.:
An Approach for Solving Multiple Travelling Salesman Problem using Ant Colony Optimization.
Comput. Eng. Intell. Syst., 6(2)13-17 (2015)

Hong S., Padberg, M. W.:
Technical Note - A Note on the Symmetric Multiple Traveling Salesman Problem with Fixed Charges.
Oper. Res., 2(5):871-874 (1977)

Hosseinabadi, A. A. R., Kardgar, M., Shojafar, M., Shamshirband, S., Abraham A.:
GELS-GA: Hybrid Metaheuristic Algorithm for Solving Multiple Travelling Salesman Problem.
ISDA14':76-81 (2014)

Jonker, R., Volgenant, T.:
Technical Note - An Improved Transformation of the Symmetric Multiple Traveling Salesman Problem.
Oper. Res., 36(1):163-167 (1988)

Junjie, P., Dingwei, W.:
An Ant Colony Optimization Algorithm for Multiple Travelling Salesman Problem.
ICICIC'06, 4 pages (2006)

Kara, I., Bektas, T.:
Integer linear programming formulations of multiple salesman problems and its variations.
Eur. J. Oper. Res., 174(3):1449-1458 (2006)

Király, A., Abonyi, J.:
Optimization of Multiple Traveling Salesmen Problem by a Novel Representation based Genetic Algorithm.
Intell. Comput. Optim. Eng., 366:241-269 (2011)

Kivelevitch, E., Cohen, K., Kumar, M.:
A Market-based Solution to the Multiple Traveling Salesmen Problem.
J. Intell. Rob. Syst., 72(1):21-40 (2013)

Kota, L., Jarmai, K.:
Mathematical modeling of multiple tour multiple traveling salesman problem using evolutionary programming.
Appl. Math. Mod., 39(12):3410-3433 (2015)

Larki, H., Yousefikhoshbakht, M.:
Solving the Multiple Traveling Salesman Problem by a Novel Metaheuristic Algorithm.
J. Optim. Ind. Eng., 7(16): 55-63 (2014)

Latah, M.:
Solving Multiple TSP Problem by K-Means and Crossover based Modified ACO Algorithm.
Int. J. Eng. Res. Tech., 5(2):430-434 (2016)

Masutti, T. A. S., Castro, L. N. De:
Neuro-immune approach to solve routing problems.
Neurocomputing, 72(10-12):2189-2197 (2009)

Mohammadpour, T., Yadollahi, M.:
Solving the Problem of Multiple Travelling Salesman Problem Using Hybrid Gravitational Algorithm.
Int. J. Comm., 3:32-37 (2014)

Necula, R., Breaban, M., Raschip, M.:
Performance Evaluation of Ant Colony Systems for the Single-Depot Multiple Traveling Salesman Problem.
International Conference on Hybrid Artificial Intelligence Systems:257-268 (2015)

Necula, R., Breaban, M., Raschip, M.:
Tackling the Bi-criteria Facet of Multiple Traveling Salesman Problem with Ant Colony Systems.
IEEE 27th International Conference on Tools with Artificial Intelligence:873-882 (2015)

Rostam, A. S., Mohanna, F., Keshavarz, H., Hosseinabadi, A. A. R.;
Solving Multiple Traveling Salesman Problem using the Gravitational Emulation Local Search Algorithm.
Appl. Math. Inf. Sci., 9(2):1-11 (2015)

Russell, R. A.;
Technical Note - An Effective Heuristic for the M-Tour Traveling Salesman Problem with Some Side Conditions.
Oper. Res., 25(3):517-524 (1977)

Salas, Y. J. C., Ledón, R. A., Machado, N. I. C., Nowé, A.:
Multi-type ant colony system for solving the multiple traveling salesman problem.
Revista Tecnica de la Facultad de Ingenieria Universidad del Zulia, 35(3): 311-320 (2012)

Sarin, S. C., Sherali, H. D., Judd, J. D., Tsai, P-F.,
Multiple asymmetric traveling salesmen problem with and without precedence constraints: Performance comparison of alternative formulations.
Comput. Oper. Res., 51: 64-89 (2014)

Sedighpour, M., Yousefikhoshbakht, M., Darani, N. M.:
An Effective Genetic Algorithm for Solving the Multiple Traveling Salesman Problem.
J. Opt. Ind. Eng., 8:73-79 (2011)

Singh, A., Baghel, A. S.:
A new grouping genetic algorithm approach to the multiple traveling salesperson problem.
Soft Comput., 13(1):95-101 (2009)

Singh, A.:
A Review on Algorithms Used to Solve Multiple Travelling Salesman Problem.
Int. Res. J. Eng. Tech., 3(4):598-603 (2016)

Somhom, S., Modares, A., Enkawa, T.:
Competition-based neural network for the multiple travelling salesmen problem with minmax objective'.
Comput. Oper. Res., 26(4):395-407 (1999)

Soylu, B.:
A general variable neighborhood search heuristic for multiple traveling salesmen problem.
Comput. Ind. Eng., 90: 390-401 (2015)

P. Venkatesh, P., Singh, A.:
Two metaheuristic approaches for the multiple traveling salesperson problem.
Appl. Soft Comput., 26:74-89 (2015)

Wacholder, E., Han J., Mann, R. C.:
A Neural Network Algorithm for the Multiple Traveling Salesmen Problem.
Biol. Cybern., 61(1):11-19 (1989)

Wang, Y., Chen, Y., Lin, Y.:
Memetic algorithm based on sequential variable neighborhood descent for the minmax multiple traveling salesman problem.
Comput. Ind. Eng., 106:105-122 (2017)

Yousefikhoshbakht, M., Sedighpour, M.:
A combination of sweep algorithm and elite ant colony optimization for solving the multiple traveling salesman problem.
Proceedings of the Romanian Academy - Series A, 13(4):295-301 (2012)

Yousefikhoshbakht, M., Didehvar, F., Rahmati, F.:
Modification of the Ant Colony Optimization for Solving the Multiple Traveling Salesman Problem.
Romanian Journal of Information Science and Technology, 16(1):65-80 (2013)

Yu Q., Wang, D., Lin, D., Li, Y., Wu, C.:
A Novel Two-Level Hybrid Algorithm for Multiple Traveling Salesman Problems.
International Conference in Swarm Intelligence:497-503 (2012)

Yuan, Y., Skinner, B., Huang, S., Liu, D.:
A new crossover approach for solving the multiple travelling salesmen problem using genetic algorithms.
Eur. J. Oper. Res., 228(1):72-82 (2013)

Zhou, H., Wei, Y.:
Optimization of Minimum Completion Time MTSP Based on the Improved DE.
Proceedings of the First international conference on Advances in Swarm Intelligence - Volume Part I:489-498 (2010)

OVRP: Open vehicle routing problem

Fleszar, K., Osman, I. H., Hindi, K. S.:
A variable neighbourhood search algorithm for the open vehicle routing problem.
Eur. J. Oper. Res., 195(3):803-809 (2009)

Li, F., Golden, B., Wasil, E.:
The open vehicle routing problem: Algorithms, large-scale test problems, and computational results.
Comput. Oper. Res., 34(10):2918-2930 (2007)

Repoussis, P. P., Tarantilis, C. D., Bräysy, O., Ioannou, G.:
A hybrid evolution strategy for the open vehicle routing problem.
Comput. Oper. Res., 37(3):443-455 (2010)

Salari, M., Toth, P., Tramontani, A.:
An ILP improvement procedure for the Open Vehicle Routing Problem.
Comput. Oper. Res., 37(12):2106-2120 (2010)

Subramanian, S.:
Heuristic, Exact and Hybrid Approaches for Vehicle Routing Problems.
PhD thesis, Universidade Federal Fluminense (2012)

Subramanian, A., Uchoa, E., Ochi, L.S.:
A hybrid algorithm for a class of vehicle routing problems.
Comput. Oper. Res., 40(10):2519-2531 (2013)

Zachariadis, E. E., Kiranoudis, C. T.:
An open vehicle routing problem metaheuristic for examining wide solution neighborhoods.
Comput. Oper. Res., 37(4):712-723 (2010)

PDPTW: Pickup-and-delivery problem with time windows

Bartolini, E.:
Algorithms for Network Design and Routing Problems.
PhD thesis, University of Bologna (2009)

Baldacci, R., Bartolini, E., Mingozzi, A.:
An Exact Algorithm for the Pickup and Delivery Problem with Time Windows.
Oper. Res., 59(2):414-426 (2011)

Bent, R., Hentenryck, P. Van:
A two-stage hybrid algorithm for pickup and delivery vehicle routing problems with time windows.
Comput. Oper. Res., 33(4):875-893 (2006)

Bettinelli, A.:
Mathematical Programming Algorithms for Transportation Problems.
PhD thesis, University of Milano (2009)

Furtado, M. G. S., Munari P., Morabito, R.:
Pickup and delivery problem with time windows: a new compact two-index formulation.
Oper. Res. Lett., 45(4):334-341 (2017)

Ganesh, K., Narendran, T. T.:
CLOVES: A cluster-and-search heuristic to solve the vehicle routing problem with delivery and pick-up.
Eur. J. Oper. Res., 178(3):699-717 (2007)

Hosny, M. I., Mumford, C. L.:
The Single Vehicle Pickup and Delivery Problem with Time Windows: Intelligent Operators for Heuristic and Metaheuristic Algorithms.
J. Heu., 16(3):417-439 (2010)

Hosny, M. I., Mumford, C. L.:
Constructing initial solutions for the multiple vehicle pickup and delivery problem with time windows.
Journal of King Saud University - Computer and Information Sciences, 24(1): 59-69 (2012)

Kalina; P., Vokínek, J.:
Parallel Solver for Vehicle Routing and Pickup and Delivery Problems with Time Windows Based on Agent Negotiation.
IEEE International Conference on Systems, Man, and Cybernetics, 6 pages (2012)

Li, H., Lim, A.:
A Metaheuristic for the Pickup and Delivery Problem with Time Windows.
Int. J. Art. Tools, 12(2):173-186 (2003).

Lu, Q., Dessouky, M. M.:
A New Insertion-based Construction Heuristic for Solving the Pickup and Delivery Problem with Time Windows.
Eur. J. Oper. Res., 175(2):672-687 (2005)

Nanry, W. P., Barnes, J. W.:
Solving the pickup and delivery problem with time windows using reactive tabu search.
Transp. Res., Part B, 34(2):107-121 (2000)

Ropke, S., Pisinger, D.:
An Adaptive Large Neighborhood Search Heuristic for the Pickup and Delivery Problem with Time Windows.
Transp. Sci., 40(4):455-472 (2006)

Ropke, S., Cordeau, J-F.:
Branch-and-Cut-and-Price for the Pickup and Delivery Problem with Time Windows.
Transp. Sci., 43(3):267-286 (2009)

PDTSP: Pickup-and-delivery traveling salesman problem

Dumitrescu, I., Ropke, S, Cordeau, J.-F., Laporte, G.:
The traveling salesman problem with pickup and delivery: polyhedral results and a branch-and-cut algorithm.
Math. Prog., 121(1):269-305 (2010)

Gendreau, M., Laporte, G., Vigo, D.:
Heuristics for the traveling salesman problem with pickup and delivery.
Comput. Oper. Res., 26(7):699-714 (1999)

Renaud, J., Boctor, F. F., Ouenniche, J.:
A heuristic for the pickup and delivery traveling salesman problem.
Comput. Oper. Res., 27(9):905-916 (2000)

Renaud, J., Boctor, F. F., Laporte, G.:
Perturbation heuristics for the pickup and delivery traveling salesman problem.
Comput. Oper. Res., 29(9):1129-1141 (2002)

PDTSPF: Pickup-and-delivery traveling salesman problem with FIFO loading

Erdoğan, G., Cordeau, J-F., Laporte, G.:
The pickup and delivery traveling salesman problem with first-in-first-out loading.
Comput. Oper. Res., 36(6):1800-1808 (2009)

Wei, L, Qin, H., Zhu, W., Wan, L.:
A study of perturbation operators for the pickup and delivery traveling salesman problem with LIFO or FIFO loading.
J. Heu., 21(5):617-639 (2015)

PDTSPL: Pickup-and-delivery traveling salesman problem with LIFO loading

Carrabs, F., Cordeau, J-F., Laporte, G.:
Variable Neighborhood Search for the Pickup and Delivery Traveling Salesman Problem with LIFO Loading.
INFORMS J. Comput., 19(4):618-632 (2007)

Cheang, B., Gao, X., Lim, A., Qin, H., Zhu, W.:
Multiple pickup and delivery traveling salesman problem with last-in-first-out loading and distance constraints.
Eur. J. Oper. Res., 223(1):60-75 (2012)

Li, Y., Lim, A., Oon, W-C., Qin, H., Tu, D.:
The tree representation for the pickup and delivery traveling salesman problem with LIFO loading.
Comput. Oper. Res., 212(3):482-496 (2011)

Wei, L, Qin, H., Zhu, W., Wan, L.:
A study of perturbation operators for the pickup and delivery traveling salesman problem with LIFO or FIFO loading.
J. Heu., 21(5):617-639 (2015)

RCTVRP: Risk-constrained cash-in-transit vehicle routing problem

Talarico, L.:
Secure Vehicle Routing: models and algorithms to increase security and reduce costs in the cash-in-transit sector.
PhD thesis, Universiteit Antwerpen (2015)

Talarico, L., Sörensen, K., Springael, J.:
Metaheuristics for the risk-constrained cash-in-transit vehicle routing problem.
Eur. J. Oper. Res., 144(3):457470 (2015)

Talarico, L., Springael, J., Sörensen, K., Talarico, F.:
A large neighbourhood metaheuristic for the risk-constrained cash-in-transit vehicle routing problem.
Comput. Oper. Res., 78:547-556 (2017)

RCTVRPTW: Risk-constrained cash-in-transit vehicle routing with time windows

Talarico, L., Sörensen, K., Springael, J.:
The risk-constrained cash-in-transit vehicle routing problem with time window.
Research paper, University of Antwerp (2013)

Talarico, L.:
Secure Vehicle Routing: models and algorithms to increase security and reduce costs in the cash-in-transit sector.
PhD thesis, Universiteit Antwerpen (2015)

SOP: Sequential ordering problem

Anghinolfi, D., Montemanni, R., Paolucci, M., Gambardella, L. M.:
A hybrid particle swarm optimization approach for the sequential ordering problem.
Comput. Oper. Res., 38(7):1076-1085 (2011)

Ascheuer, N., Jünger, M., Reinelt, G.:
A Branch & Cut Algorithm for the Asymmetric Traveling Salesman Problem with Precedence Constraints.
Comput. Optim. Appl., 17(1):61-71 (2000)

Ezzat, A., Abdelbar, A. M., Wunsch II, D. C.:
A bare-bones ant colony optimization algorithm that performs competitively on the sequential ordering problem.
Mem. Comput., 6(1):19-29 (2014)

Gambardella, L. M., Dorigo, M.:
An Ant Colony System Hybridized with a New Local Search for the Sequential Ordering Problem.
INFORMS J. Comput., 12(3):237-255 (2000)

Gambardella, L. M., Montemanni, R., Weyland, D.:
An Enhanced Ant Colony System for the Sequential Ordering Problem.
Oper. Res. Proc. 2011:355-360 (2012)

Gambardella, L. M., Montemanni, R., Weyland, D.:
Coupling ant colony systems with strong local searches.
Eur. J. Oper. Res., 220(3):831-843 (2012)

Gambardella, L. M.:
Coupling Ant Colony System with Local Search.
PhD thesis, IRIDIA, Université Libre de Bruxelles (2015)

Gouveia, L., Ruthmair, M.:
Load-Dependent and Precedence-Based Models for Pickup and Delivery Problems.
Comput. Oper. Res., 63:56-71 (2015)

Guerriero, F., Mancini, M.:
A cooperative parallel rollout algorithm for the sequential ordering problem.
Par. Comput. 29(5):663-677 (2003)

Montemanni, R., Smith, D. H., Gambardella, L. M.:
A Heuristic Manipulation Technique for the Sequential Ordering Problem.
Comput. Oper. Res., 35(12):3931-3944 (2008)

Montemanni, R., Mojana, Caro, M., A. Di, Gambardella, L. M.:
A decomposition-based exact approach for the sequential ordering problem.
J. Appl. Oper. Res., 5(1):2-13 (2013)

Moon, C., Kim, J., Choi, G., Seo, Y.:
An efficient genetic algorithm for the traveling salesman problem with precedence constraints.
Eur. J. Oper. Res., 140(3):606-617 (2002)

Nikolakopoulos, A., Sarimveis, H.:
A threshold accepting heuristic with intense local search for the solution of special instances of the traveling salesman problem.
Eur. J. Oper. Res., 177(3):1911-1929 (2007)

Papapanagiotou, V., Jamal, J., Montemanni, R., Shobaki, G., Gambardella, L. M.:
A comparison of two exact algorithms for the sequential ordering problem.
Technical Report No. IDSIA-12-15, IDSIA / USI-SUPSI (2015)

Psaraftis, H. N.:
k-Interchange procedures for local search in a precedence-constrained routing problem.
Eur. J. Oper. Res., 13(4):391-402 (1983)

Seo, D-I., Moon, B-R.:
A Hybrid Genetic Algorithm Based on Complete Graph Representation for the Sequential Ordering Problem.
GECCO 2003, LNCS 2723:669-680 (2003)

Shobaki, G., Jamal, J.:
An exact algorithm for the sequential ordering problem and its application to switching energy minimization in compilers.
Comput. Optim. Appl., 61(2):343-372 (2015)

Skinderowicz, R.:
Population-Based Ant Colony Optimization for Sequential Ordering Problem.
ICCCI 2015, Part II, LNCS 9330:99-109 (2015)

Skinderowicz, R.:
An improved Ant Colony System for the Sequential Ordering Problem'.
Comput. Oper. Res., 86:1-17 (2017)

Sung, J, Jeong, B.:
An Adaptive Evolutionary Algorithm for Traveling Salesman Problem with Precedence Constraints.
Scientific World J., Article ID 313767, 11 pages (2014)

TRP: Traveling repairman problem

Blum, A. Chalasani, P., Coppersmith, D., Pulleyblank, B., Raghavan, P., Sudan, M.:
The Minimum Latency Problem.
STOC ’94:163-171 (1994)

Salehipour, A., Sörensen, K., Goos, P., Bräysy, O.:
Efficient GRASP+VND and GRASP+VNS metaheuristics for the traveling repairman problem.
4OR-Q. J. Oper. Res, 9:189–209 (2011)

Silva M. M., Subramanian, A., Vidal T., Ochi, L. S.:
A simple and effective metaheuristic for the Minimum Latency Problem.
Eur. J. Oper. Res., 221(3):513-520 (2012)

Wu, B. Y., Huang, Z-N., Zhan, F-J.:
Exact algorithms for the minimum latency problem.
Inf. Proc. Lett., 92(6): 303-309 (2004)

TSPPD: Traveling salesman problem with pickups and deliveries

Mosheiov, G.:
The travelling salesman problem with pickup and delivery.
Eur. J. Oper. Res., 79:299-310 (1994)

TSPTW: Traveling salesman problem with time windows

Ascheuer, N., Fischetti, M., Grötschel, M.:
Solving the Asymmetric Travelling Salesman Problem with time windows by branch-and-cut.
Math. Prog., Ser. A 90:475-506 (2001)

Baldacci, R., Mingozzi, A., Roberti, R.:
New State-Space Relaxations for Solving the Traveling Salesman Problem with Time Windows.
INFORMS J. Comput., 24(3):356-371 (2012)

Calvo, R. W.:
A New Heuristic for the Traveling Salesman Problem with Time Windows.
Transp. Sci, INFORMS, 34(1):113-124 (2000)

Dash, S., Günlük, O., Lodi, A., Tramontani, A.:
A Time Bucket Formulation for the TSP with Time Windows.
INFORMS J. Comput., 24(1):132-147 (2010)

Dumas, Y., Desrosiers, Gelinas, J. E., Solomon, M. M.:
An Optimal Algorithm for the Traveling Salesman Problem with Time Windows.
Oper. Res., 43(2):367-371 (1995)

Edelkamp, S., Gath, M., Cazenavey, T., Teytaud, F.:
Algorithm and Knowledge Engineering for the TSPTW Problem.
2013 IEEE Symposium on Computational Intelligence in Scheduling, 8 pages (2013)

Favaretto, D., Moretti, E., Pellegrini, P.:
Ant Colony System for variants of Traveling Salesman Problem with Time Windows.
Technical Report, Ca'Foscari University of Venice, No. 120/2004 (2004)

Focacci, F., Lodi, A., Milano, M.:
A Hybrid Exact Algorithm for the TSPTW.
INFORMS J. Comput., 14(4):403-417 (2002)

Gendreau, M., A. Hertz, Laporte, G., Stan, M.:
A Generalized Insertion Heuristic for the Traveling Salesman Problem with Time Windows.
Oper. Res., 46(3):330-335 (1998)

Langevin, A., Desrochers, M., Desrosiers, J., Gélinas, S., Soumis, F.:
A two-commodity flow formulation for the travelling salesman and makespan problems with time windows.
Networks, 23:631-640 (1993)

Li, J-Q.:
A Computational Study of Bi-directional Dynamic Programming for the Traveling Salesman Problem with Time Windows.
Technical report, Working paper, University of California, Berkeley (2009)

López-Ibáñez, M., Blum, C., Thiruvady, D., Ernst, A. T., Meyer, B.:
Beam-ACO Based on Stochastic Sampling for Makespan Optimization Concerning the TSP with Time Windows.
EvoCOP 2009, LNCS 5482:97-108 (2009)

López-Ibáñez, M., Blum, C.:
Beam-ACO for the travelling salesman problem with time windows.
Comput. Oper. Res., 37(9):1570-1583 (2010)

Karabulut, K., Tasgetiren, M. F.:
A variable iterated greedy algorithm for the traveling salesman problem with time windows.
Inform. Sci., 279:383-395 (2014)

Mladenović, M., Todosijević R., Urosević, D.:
An efficient general variable neighborhood search for large travelling salesman problem with time windows.
Yugoslav J. Oper. Res., 23(1):20-30 (2016)

Ohlmann, J. W., Thomas, B. W.:
A Compressed-Annealing Heuristic for the Traveling Salesman Problem with Time Windows.
INFORMS J. Comput., 19(1):80-90 (2007)

Pesant, G., Gendreau, M., Potvin, J.Y., Rousseau, J.M.:
An exact constraint logic programming algorithm for the travelling salesman problem with time windows.
Transp. Sci., 32:12-29 (1998)

Potvin, J.Y., Bengio, S.:
The vehicle routing problem with time windows part II: genetic search.
INFORMS J. Comput., 8:165-172 (1996)

Silva, R. F. da, Urrutia, S.:
A General VNS heuristic for the traveling salesman problem with time windows.
Discrete Optim., 7(4):203-211 (2010)

Solomon, M. M.:
Algorithms for the Vehicle Routing and Scheduling Problems with Time Window Constraints.
Oper. Res., 35(2):254-265 (1987)

VRPB: Vehicle routing problem with backhauls

Brandão, J.:
A new tabu search algorithm for the vehicle routing problem with backhauls.
Eur. J. Oper. Res., 173(2):540-555 (2005)

Catay, B.:
Ant Colony Optimization and Its Application to the Vehicle Routing Problem with Pickups and Deliveries.
Studies in Computational Intelligence, 250:219-244 (2009)

Cuervo, D. P., Goos, P., Sörensen, K., Arráiz, E.:
An iterated local search algorithm for the vehicle routing problem with backhauls.
Eur. J. Oper. Res., 237(2):454-464 (2014)

Gajpal, Y., Abad, P. L.:
Multi-ant colony system (MACS) for a vehicle routing problem with backhauls.
Eur. J. Oper. Res., 196(1):102-117 (2009)

Gélinas, S., Desrochers, M., Desrosiers, J., Solomon, M. M.:
A new branching strategy for time constrained routing problems with application to backhauling.
Ann. Oper. Res., 61:91-109 (1995)

Ghaziri H., Osman, I. H.:
A neural network algorithm for the traveling salesman problem with backhauls.
Comput. Ind. Eng., 44(2):267-281 (2003)

Ghaziri H., Osman, I. H.:
Self-organizing feature maps for the vehicle routing problem with backhauls.
J. Sched. 9(2):97-114 (2006)

Goetschalckx M., Jacobs-Blecha C.
The vehicle routing problem with Backhauls.
Eur. J. Oper. Res., 42: 9-51 (1989)

Jacobs-Blecha, C. D., Goetscalckx, M.:
The Vehicle Routing Problem with Backhauls: Properties and Solution Algorithms.
Material Handling Research Center, Georgia Institute of Technology (1992)

Mingozzi, A., Giorgi, S., Baldacci, R.:
An Exact Method for the Vehicle Routing Problem with Backhauls.
Transp. Sci., 33(3):315-329 (1999)

Nagy, G., Salhi, S.:
Heuristic algorithms for single and multiple depot vehicle routing problems with pickups and deliveries.
Eur. J. Oper. Res. 162(1):126-141 (2005)

Osman, I. H., Wassan, N. A.:
A reactive tabu search meta-heuristic for the vehicle routing problem with back-hauls.
J. Sched., 5(4):263-285 (2002)

Parragh, S.N., Doerner, K. F., Hartl, R. F.:
A survey on pickup and delivery problems. Part I: Transportation between customers and depot.
Journal für Betriebswirtschaft, 58(1):21-51 (2008)

Parragh, S.N., Doerner, K. F., Hartl, R. F.:
A survey on pickup and delivery problems. Part II: Transportation between pickup and delivery locations.
Journal für Betriebswirtschaft, 58(2):81-117 (2008)

Pisinger, D., Ropke, S.:
A general heuristic for vehicle routing problems.
Comput. Oper. Res., 34(8):2403-2435 (2005)

Ropke, S., Pisinger, D.:
A unified heuristic for a large class of Vehicle Routing Problems with Backhauls.
Eur. J. Oper. Res., 171(3):750-775 (2006)

Toth, P., Vigo, D.:
An Exact Algorithm for the Vehicle Routing Problem with Backhauls.
Transp. Sci., 32(4):372-385 (1997)

Toth, P., Vigo, D.:
A heuristic algorithm for the symmetric and asymmetric vehicle routing problems with backhauls.
Eur. J. Oper. Res., 113(3):528-543 (1999)

Wade, A., Salhi, S.:
An Ant System Algorithm for the Vehicle Routing Problem with Backhauls.
MIC'2001 - 4th Metaheuristics International Conference:199-203 (2001)

Wang, Z., Wang, Z.:
A novel two-phase heuristic method for vehicle routing problem with backhauls.
Comput. Math. Appl., 57(11-12):1923-1928 (2009)

Yalcin, G. D., Erginel, N.:
A Heuristic Based on Integer Programming for the Vehicle Routing Problem with Backhauls.
IEOM 2012:1350-1358 (2012)

Zachariadis, E. E., Kiranoudis, C. T.:
An Innovative Metaheuristic Solution Approach for the Vehicle Routing Problem with Backhauls.
Exp. Syst. Appl., 39(3):3174-3184 (2012)

VRPBTW: Vehicle routing problem with backhauls and time windows

Gélinas S., Desrochers, M., Desrosiers J., Solomon, M. M.:
A new branching strategy for time constrained routing problems with application to backhauling.
Ann. Oper. Res., 61:91-109 (1995)

Nalepa, J., Czech, Z. J.:
A Parallel Memetic Algorithm to Solve the Vehicle Routing Problem with Time Windows.
Studia Informatica, 33(1):91-106 (2012)

Reimann, M., Doerner, K., Hartl, R. F.:
Insertion Based Ants for Vehicle Routing Problems with Backhauls and Time Windows.
ANTS 2002, LNCS 2463:135-148 (2002)

Ropke, S., Pisinger, D.:
A unified heuristic for a large class of Vehicle Routing Problems with Backhauls.
Eur. J. Oper. Res., 171(3):750-775 (2006)

Ropke, S.:
Heuristic and exact algorithms for vehicle routing problems.
PhD thesis, DIKU, University of Copenhagen (2005)

Thangiah, S. R., Potvin, J.-Y., T. Sun, T.:
Heuristic Approaches to Vehicle Routing with Backhauls and Time Windows.
Comput. Oper. Res., 23(11):1043-1057 (1996)

Zhong, Y., Cole, M. H.:
A vehicle routing problem with backhauls and time windows: a guided local search solution.
Transp. Res., Part E 41:131-144 (2005)

VRPMPD: Vehicle routing problem with mixed pickup and delivery

Avci, M., Topaloglu, S.:
An adaptive local search algorithm for vehicle routing problem with simultaneous and mixed pickups and deliveries.
Comput. Ind. Eng., 83:15-29 (2015)

Catay, B.:
An ant colony algorithm for the mixed vehicle routing problem with backhauls.
3rd World Conference on Production and Operations Management, 9 pages (2008)

Crispim, J., Brandão, J.:
Metaheuristics applied to mixed and simultaneous extensions of vehicle routing problems with backhauls.
J. Oper. Res. Soc., 56(11):1296-1302 (2005)

García-Nájera, A., Bullinaria, J., Gutiérrez-Andrade, M.;
An evolutionary approach for multi-objective vehicle routing problems with backhauls.
Comput. Ind. Eng., 81:90-108 (2015)

Nagy, G., Wassan, N. A., Salhi, S.:
The vehicle routing problem with restricted mixing of deliveries and pickups.
J. Sched., 16(2):199-213 (2013)

Salhi, S., Nagy, G.:
A Cluster Insertion Heuristic for Single and Multiple Depot Vehicle Routing Problems with Backhauling.
J. Oper. Res. Soc., 50(10):1034-1042 (1999)

Tütüncü, G. Y., Carreto, C. A. C., Baker, B. M.;
A visual interactive approach to classical and mixed vehicle routing problems with backhauls.
Omega, 37(1):138.154 (2009)

VRPMPDTW: Vehicle routing problem with mixed pickup and delivery and time windows

Gélinas S., Desrochers, M., Desrosiers J., Solomon, M. M.:
A new branching strategy for time constrained routing problems with application to backhauling.
Ann. Oper. Res., 61:91-109 (1995)

Nalepa, J., Czech, Z. J.:
A Parallel Memetic Algorithm to Solve the Vehicle Routing Problem with Time Windows.
Studia Informatica, 33(1):91-106 (2012)

Ropke, S., Pisinger, D.:
A unified heuristic for a large class of Vehicle Routing Problems with Backhauls.
Eur. J. Oper. Res., 171(3):750-775 (2006)

Ropke, S.:
Heuristic and exact algorithms for vehicle routing problems.
PhD thesis, DIKU, University of Copenhagen (2005)

Thangiah, S. R., Potvin, J.-Y., T. Sun, T.:
Heuristic Approaches to Vehicle Routing with Backhauls and Time Windows.
Comput. Oper. Res., 23(11):1043-1057 (1996)

Zhong, Y., Cole, M. H.:
A vehicle routing problem with backhauls and time windows: a guided local search solution.
Transp. Res., Part E 41:131-144 (2005)

VRPSPD: Vehicle routing problem with simultaneous pickup and delivery

Ai, T. J., Kachitvichyanukul, V.:
A particle swarm optimization for the vehicle routing problem with simultaneous pickup and delivery.
Comput. Oper. Res., 36(5):1693-1702 (2009)

Avci, M., Topaloglu, S.:
An adaptive local search algorithm for vehicle routing problem with simultaneous and mixed pickups and deliveries.
Comput. Ind. Eng., 83:15-29 (2015)

B. Catay,
A new saving-based ant algorithm for the Vehicle Routing Problem with Simultaneous Pickup and Delivery.
Expert Syst. Appl., 37(10):6809-6817 (2010)

Crispim, J., Brandão, J.:
Metaheuristics applied to mixed and simultaneous extensions of vehicle routing problems with backhauls.
J. Oper. Res. Soc., 56(11):1296-1302 (2005)

Dethloff, J.:
Vehicle routing and reverse logistics: the vehicle routing problem with simultaneous delivery and pick-up.
OR Spektrum, 23(1):79-96 (2001)

Dethloff, J.:
Relation between Vehicle Routing Problems: An Insertion Heuristic for the Vehicle Routing Problem with Simultaneous Delivery and Pick-Up Applied to the Vehicle Routing Problem with Backhauls.
J. Oper. Res. Soc., 53(1):115-118 (2002)

Gajpal, Y., Abad, P.:
An ant colony system (ACS) for vehicle routing problem with simultaneous delivery and pickup.
Comput. Oper. Res., 36(12):3215-3223 (2009)

García-Nájera, A., Bullinaria, J., Gutiérrez-Andrade, M.;
An evolutionary approach for multi-objective vehicle routing problems with backhauls.
Comput. Ind. Eng., 81:90-108 (2015)

Jiang, Q., Wang, C., Mu, D., Zhou, L.:
A Hybrid Metaheuristic Algorithm for the VRPSPD Problem.
J. Comput. Inf. Syst., 11(13):4845-4856 (2015)

Jun, Y. Kim, B-I.,
New best solutions to VRPSPD benchmark problems by a perturbation based algorithm.

Exp. Syst. Appl., 29(5):5641-5648 (2012)
Kalayci, C. B., Kaya, C.:
An ant colony system empowered variable neighborhood search algorithm for the vehicle routing problem with simultaneous pickup and delivery.
Exp. Syst. Appl., 66(30):163-175 (2016)

Li, J., Pardalos, M., Sun, H., Pei, J., Zhang, Y.:
Iterated local search embedded adaptive neighborhood selection approach for the multi-depot vehicle routing problem with simultaneous deliveries and pickups.
Exp. Syst. Appl., 42(7):3551-3561 (2015)

Montané, F. A. T., Galvão, R. D.:
A tabu search algorithm for the vehicle routing problem with simultaneous pick-up and delivery service.
Comput. Oper. Res., 33(3):595-619 (2006)

Phannikul, T., Sindhuchao, S.:
A Customized Tabu Search for the Vehicle Routing Problem with Simultaneous Pick-up and Delivery.
Thammasat Int. J. Sci. Tech., 15(2):70-82 (2010)

Rieck, R., Zimmermann, J.:
Exact Solutions to the Symmetric and Asymmetric Vehicle Routing Problem with Simultaneous Delivery and Pick-Up.
J. Bus. Res., 6(1):77-92 (2013)

Salhi, S., Nagy, G.:
A Cluster Insertion Heuristic for Single and Multiple Depot Vehicle Routing Problems with Backhauling.
J. Oper. Res. Soc., 50(10):1034-1042 (1999)

Shahdaei, A. M., Rahimi, A. M.:
Solving Vehicle Routing Problem with Simultaneous Pickup and Delivery with the Application of Genetic Algorithm.
Indian Journal of Fundamental and Applied Life Sciences, 6:247-259 (2016)

VRPSPDTW: Vehicle routing problem with simultaneous pickup-delivery and time windows

Pisinger, D., Ropke, S.:
A general heuristic for vehicle routing problems.
Comput. Oper. Res., 34(8):2403-2435 (2005)

Wang, C., Mu, D., Zhao, F., Sutherland, J. W.:
A parallel simulated annealing method for the vehicle routing problem with simultaneous pickup–delivery and time windows.
Comput. Ind. Eng., 83:111-122 (2015)