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Districting for routing with stochastic customers

Abstract

We introduce the vehicle routing and districting problem with stochastic customers (VRDPSC). This problem is modelled and solved as a two-stage stochastic program during which the districting decisions are made in the first stage and the Beardwood–Halton–Hammersley formula is used to approximate the expected routing cost of each district in the second stage. District compactness is also considered as part of the objective function. We have developed a large neighbourhood search heuristic for VRDPSC. The heuristic was tested on modified Solomon instances and on modified Gehring and Homberger instances. Extensive computational results confirm the effectiveness of the proposed heuristic.

Within this Article

1. Introduction
2. Mathematical modeling as a stochastic program
3. Approximation of the expected routing cost in a district
4. Compactness measure of a district
5. Large neighbourhood search heuristic
6. Computational experiments
7. Conclusions
8. References
9. References

Related Content

References (37)

1. Applegate DL, Bixby RE, Chvátal V, Cook WJ (2006) The travelling salesman problem: a computational study. Princeton University Press
2. Beardwood J, Halton JH, Hammersley JM (1959) The shortest path through many points. Mathematical Proceedings of the Cambridge Philosophical Society 55(4). Cambridge University Press, 299–327
3. Bertsimas DJ (1992) A vehicle routing problem with stochastic demand. Oper Res 40(3):574–585 CrossRef
4. Bertsimas DJ, Jaillet P, Odoni AR (1990) A priori optimization. Oper Res 38(6):1019–1033 CrossRef
5. Blais M, Lapierre SD, Laporte G (2003) Solving a home care districting problem in an urban setting. J Oper Res Soc 54(11):1141–1147 CrossRef
6. Bozkaya B, Erkut E, Laporte G (2003) A tabu search heuristic and adaptive memory procedure for political districting. Eur J Oper Res 144(1):12–26 CrossRef
7. Carlsson JG (2011) Dividing a territory among several facilities. INFORMS J Computi. doi:10.1287/ijoc.1110.0479
8. Carlsson JG, Delage É (2011) Robust partitioning for stochastic multi-vehicle routing. Technical report of the Boeing Company.
9. D'Amico SJ, Wang SJ, Batta R, Rump CM (2002) A simulated annealing approach to police district design. Comput Oper Res 29(6): 667–684 CrossRef
10. Drexl A, Haase K (1999) Fast approximation methods for sales force deployment. Manag Sci 45(10): 1307–1323 CrossRef
11. Dueck G (1993) New optimization heuristics: the great deluge algorithm and the record-to-record travel. J Comput Phys 104(1): 86–92 CrossRef
12. Ferland JA, Guénette G (1990) Decision support system for the school districting problem. Oper Res 38(1):15–21 CrossRef
13. Fleischmann B, Paraschis J (1988) Solving a large scale districting problem: a case report. Comput Oper Res 15(6):521–533 CrossRef
14. Gehring H, Homberger J (1999) A parallel hybrid evolutionary metaheuristic for the vehicle routing problem with time windows. In: Miettinen K, Mäkelä M, Toivanen J (Eds.) Proceedings of EUROGEN99—short course on evolutionary algorithms in engineering and computer science, Reports of the Department of Mathematical Information Technology, Series A. Collections, No. A 2/1999. University of Jyväskylä, Finland, 57–64.
15. Gendreau M, Laporte G, Séguin R (1996) A tabu search heuristic for the vehicle routing problem with stochastic demands and customers. Oper Res 44(3):469–477 CrossRef
16. Goel A, Gruhn V (2008) A general vehicle routing problem. Euro J Oper Res 191(3):650–660 CrossRef
17. Groër C, Golden BL, Wasil EA (2009) The consistent vehicle routing problem. Manuf Serv Oper Manag 11(4): 630–643 CrossRef
18. Haugland D, Ho SC, Laporte G (2007) Designing delivery districts for the vehicle routing problem with stochastic demands. Euro J Oper Res 180(3): 997–1010 CrossRef
19. Hong L (2012) An improved LNS algorithm for real-time vehicle routing problem with time windows. Comput Oper Res 39(2): 151–163 CrossRef
20. Jaillet P (1988) A priori solution of a traveling salesman problem in which a random subset of the customers are visited. Oper Res 36(6): 929–936 CrossRef
21. Kalcsics J, Nickel S, Schröder M (2005) Towards a unified territorial design approach—applications, algorithms and GIS integration. TOP 13(1): 1–56 CrossRef

22. Laporte G, Louveaux FV, Mercure H (1994) A priori optimization of the probabilistic traveling salesman problem. Oper Res 42(3):543–549 CrossRef

23. Laporte G, Louveaux FV, Van hamme L (2002) An integer L-shaped algorithm for the capacitated vehicle routing problem with stochastic demands. Oper Res 50(3):415–423 CrossRef

24. Laporte G, Musmanno R, Vocaturo F (2010) An adaptive large neighbourhood search heuristic for the capacitated arc routing problem with stochastic demands. Transp Sci 44(1):125–135 CrossRef

25. Lei H, Laporte G, Guo B (2011) The capacitated vehicle routing problem with stochastic demands and time windows. Comput Oper Res 38(12):1775–1783 CrossRef

26. Mehrotra A, Johnson EL, Nemhauser GL (1992) An optimization based heuristic for political districting. Manag Sci 44(8):1100–1114 CrossRef

27. Mendoza JE, Castanier B, Guéret C, Medaglia AL, Velasco N (2010) A memetic algorithm for the multi-compartment vehicle routing problem with stochastic demands. Comput Oper Res 37(11):1886–1898 CrossRef

28. Novaes AGN, Souza de Cursi JE, da Silva ACL, Souza JC (2009) Solving continuous location-districting problems with Voronoi diagrams. Comput Oper Res 36(1):40–59 CrossRef

29. Pisinger D, Ropke S (2007) A general heuristic for vehicle routing problems. Comput Oper Res 34(8):2403–2435 CrossRef

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

31. Ríos-Mercado RZ, Fernández E (2009) A reactive GRASP for a commercial territory design problem with multiple balancing requirements. Comput Oper Res 36(3):755– 776 CrossRef

32. Ropke S, Pisinger D (2006) An adaptive large neighborhood search heuristic for the pickup and delivery problem with time windows. Transp Sci 40(4):455–472 CrossRef

33. Shaw P (1997) A new local search algorithm providing high quality solutions to vehicle routing problems. Technical report, Department of Computer Science, University of Strathclyde, Glasgow.

34. Shaw P (1998) Using constraint programming and local search methods to solve vehicle routing problems. Principles and Practice of Constraint Programming-CP98, Lecture Notes in Computer Science, vol 1520. Springer, Berlin, 417–431

35. Skiera B, Albers S (1998) COSTA: Contribution optimizing sales territory alignment. Mark Sci 17(3):196–213 CrossRef

36. Solomon MM (1987) Algorithms for the vehicle routing and scheduling problems with time window constraints. Oper Res 35(2):254–265 CrossRef

37. Tan KC, Cheong CY, Goh CK (2007) Solving multiobjective vehicle routing problem with stochastic demand via evolutionary computation. Eur J Oper Res 177(2):813–839 CrossRef

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