



## A new hybrid algorithm for solving the vehicle routing problem with route balancing

S.H. Huang<sup>a</sup>, Y.H. Huang<sup>b,\*</sup>, H.C. Lee<sup>a</sup>, Y.Y. Tong<sup>a</sup>

<sup>a</sup> National Kaohsiung University of Science and Technology, Department of Logistics Management, Kaohsiung, Taiwan;

<sup>b</sup> National Yunlin University of Science and Technology, Department of Civil and Construction Engineering, Yunlin, Taiwan

### References

- [1] M. M. Solomon, "Algorithms for the vehicle routing and scheduling problems with time window constraints," *Oper. Res.*, vol. 35, no. 2, pp. 166-324, 1987, doi: 10.1287/opre.35.2.254.
- [2] E. Choi, and D. W. Tcha, "A column generation approach to the heterogeneous fleet vehicle routing problem," *Comput. Oper. Res.*, vol. 34, no. 7, pp. 2080-2095, 2007, doi: 10.1016/j.cor.2005.08.002.
- [3] M. Yousefikhoshbakht, F. Didehvar, and F. Rahmati, "Solving the heterogeneous fixed fleet open vehicle routing problem by a combined metaheuristic algorithm," *Int. J. Prod. Res.*, vol. 52, no. 9, pp. 2565-2575, 2014, doi: 10.1080/00207543.2013.855337.
- [4] M. Polacek, R. F. Hartl, K. Doerner, and M. Reimann, "A variable neighborhood search for the multi depot vehicle routing problem with time windows," *J. Heuristics*, vol. 10, pp. 613-627, 2004, doi: 10.1007/s10732-005-5432-5.
- [5] R. Dondo, and J. Cerda, "A cluster-based optimization approach for the multi-depot heterogeneous fleet vehicle routing problem with time windows," *Eur. J. Oper. Res.*, vol. 176, pp. 1478-1507, 2007, doi: 10.1016/j.ejor.2004.07.077.
- [6] B. Crevier, J. F., Cordeau, and G. Laporte, "The multi-depot vehicle routing problem with inter-depot routes," *Eur. J. Oper. Res.*, vol. 176, pp. 756-773, 2007, doi: 10.1016/j.ejor.2005.08.015.
- [7] M. Ostermeier, S. Martins, P. Amorim, and A. Hübner, "Loading constraints for a multi-compartment vehicle routing problem," *OR Spectrum*, vol. 40, pp. 997-1027, 2018, doi: 10.1007/s00291-018-0524-4.
- [8] M. Reed, A. Yiannakou, and R. Evering, "An ant colony algorithm for the multi-compartment vehicle routing problem," *Appl. Soft Comput.*, vol. 15, pp. 169-176, 2014, doi: 10.1016/j.asoc.2013.10.017.
- [9] H. Hernandez-Perez, and J. J. Salazar-Gonzalez, "Heuristics for the one commodity pickup-and-delivery travelling salesman problem," *Transport. Sci.*, vol. 38, pp. 245-255, 2004, doi: 10.1287/trsc.1030.0086.
- [10] H. Hernandez-Perez, I. Rodriguez-Martín, and J. J. Salazar-Gonzalez, "A hybrid heuristic approach for the multi-commodity pickup-and-delivery traveling salesman problem," *Eur. J. Oper. Res.*, vol. 251, pp. 44-52, 2016, doi: 10.1016/j.ejor.2015.10.053.
- [11] O. Belgin, I. Karaoglan, and F. Altıparmak, "Two-echelon vehicle routing problem with simultaneous pickup and delivery: Mathematical model and heuristic approach," *Comput. Ind. Eng.*, vol. 115, pp. 1-16, 2018, doi: 10.1016/j.cie.2017.10.032.
- [12] Y. H. Huang, C. A. Blazquez, S. H. Huang, and G. Paredes-Belmar, "Solving the Feeder Vehicle Routing Problem using ant colony optimization," *Comput. Ind. Eng.*, vol. 127, pp. 520-535, 2019, doi: 10.1016/j.cie.2018.10.037.
- [13] H. Park, and S. Jin, "Electric vehicle routing problem with heterogeneous vehicles and partial charge," *Int. J. Ind. Eng. Manage.*, vol. 11, no. 4, pp. 215-225, 2020, doi: 10.24867/IJEM-2020-4-266.
- [14] A. L. Erera, J. C. Morales, and M. Savelsbergh, "The vehicle routing problem with stochastic demand and duration constraints," *Transport. Sci.*, vol. 44, no. 4, pp. 474-492, 2010, doi: 10.1287/trsc.1100.0324.
- [15] S. H. Huang, and P. C. Lin, "A modified ant colony optimization algorithm for multi-item inventory routing problems with demand uncertainty," *Transport. Res. E*, vol. 46, pp. 598-611, 2010, doi: 10.1016/j.tre.2010.01.006.
- [16] G. Laporte, F. V. Louveaux, and L. van Hamme, "An integer L-Shaped algorithm for the capacitated vehicle routing problem with stochastic demands," *Oper. Res.*, vol. 50, no. 3, pp. 415-423, 2002, doi: 10.1287/opre.50.3.415.7751.
- [17] W. Rei, M. Gendreau, and P. "A hybrid Monte Carlo local branching algorithm for the single vehicle routing problem with stochastic demands," *Transport. Sci.*, vol. 44, no. 1, pp. 136-146, 2010, doi: 10.1287/trsc.1090.0295.
- [18] L. C. Lu, and T. W. Yue, "Mission-oriented ant-team ACO for min-max MTSP," *Appl. Soft Comput.*, vol. 76, pp. 436-444, 2019, doi: 10.1016/j.asoc.2018.11.048.

- [19] I. Borgulya, "An algorithm for the capacitated vehicle routing problem with route balancing," *Cent. Eur. J. Oper. Res.*, vol. 16, no. 4, pp. 331–343, 2008, doi: 10.1007/s10100-008-0062-2.
- [20] E. E. Halvorsen-Weare, and M. W. P. Savelsbergh, "The bi-objective mixed capacitated general routing problem with different route balance criteria," *Eur. J. Oper. Res.*, vol. 251, no. 2, pp. 451–465, 2016, doi: 10.1016/j.ejor.2015.11.024.
- [21] Z. Zhang, Y. Sun, H. Xie, Y. Teng, and J. Wang, "GMMA: GPU-based multi-objective memetic algorithms for vehicle routing problem with route balancing," *Appl. Intell.*, vol. 49, pp. 63–78, 2019, doi: 10.1007/s10489-018-1210-6.
- [22] J. Oyola, and A. Lokketangen, "GRASP-ASP: An algorithm for the CVRP with route balancing," *J. Heuristics*, vol. 20, pp. 361–382, 2014, doi: 10.1007/s10732-014-9251-4.
- [23] N. Jozefowicz, F. Semet, and E.G. Talbi, "An evolutionary algorithm for the vehicle routing problem with route balancing," *Eur. J. Oper. Res.*, vol. 195, pp. 761–769, 2009, doi: 10.1016/j.ejor.2007.06.065.
- [24] T. Keskinturk, and M. B. Yildirim, "A genetic algorithm metaheuristic for bakery distribution vehicle routing problem with load balancing," in *Innovations in Intelligent Systems and Applications (INISTA)*, 2011, doi: 10.1109/INISTA.2011.5946077.
- [25] J. Lozano, L. -C. González-Gurrola, E. Rodríguez-Tello and P. Lacomme, "A Statistical Comparison of Objective Functions for the Vehicle Routing Problem with Route Balancing," in *2016 Fifteenth Mexican International Conference on Artificial Intelligence (MICAI)*, Cancun, Mexico, 2016, pp. 130-135, doi: 10.1109/MICAI-2016.2016.00028.
- [26] L. I. Jingjing, Y. Fang, and N. Tang, "A cluster-based optimization framework for vehicle routing problem with workload balance," *Comput. Ind. Eng.*, vol. 169, 108221, 2022, doi: 10.1016/j.cie.2022.108221.
- [27] R. Linfati, F. Yáñez-Concha, and J. W. Escobar, "Mathematical models for the vehicle routing problem by considering balancing load and customer compactness," *Sustainability*, vol. 14, no. 19, 12937, 2022, doi: 10.3390/su141912937.
- [28] B. L. Golden, G. Laporte, and E. D. Taillard, "An adaptive memory heuristic for a class of vehicle routing problems with minmax objective," *Comput. Oper. Res.*, vol. 24, no. 5, pp. 445–452, 1997, doi: 10.1016/S0305-0548(96)00065-2.
- [29] L. Bertazzi, B. Golden, and X. Wang, "Min-max vs. min-sum vehicle routing: a worst-case analysis," *Eur. J. Oper. Res.*, vol. 240, pp. 372–381, 2015, doi: 10.1016/j.ejor.2014.07.025.
- [30] E. Yakici, "A heuristic approach for solving a rich min-max vehicle routing problem with mixed fleet and mixed demand," *Comput. Ind. Eng.*, vol. 109, pp. 288–294, 2017, <https://doi.org/10.1016/j.cie.2017.05.001>.
- [31] M. Rabbani, M. Akbarpour, M. Hosseini, and H. Farrokhi-Asl, "A multi-depot vehicle routing problem with time windows and load balancing: a real world application," *Int. J. Supply and Operations Management*, vol. 8, no. 3, pp. 347–369, 2021, doi: 10.22034/IJSOM.2021.3.7.
- [32] K. V. Narasimha, E. Kivelevitch, B. Sharma, and M. Kumar, "An ant colony optimization technique for solving min-max multi-depot vehicle routing problem," *Swarm Evol. Comput.*, vol. 13, pp. 63–73, 2013, doi: 10.1016/j.swevo.2013.05.005.
- [33] X. Wang, B. Golden, E. Wasil, and R. Zhang, "The min-max split delivery multi-depot vehicle routing problem with minimum service time requirement," *Comput. Oper. Res.*, vol. 71, pp. 110–126, 2016, doi: 10.1016/j.cor.2016.01.008.
- [34] Y. Wang, L. Zhao, M. Savelsbergh, and S. Wu, "Multi-period workload balancing in last-mile urban delivery," *Transport. Sci.*, vol. 56, no. 5, pp. 1348–1368, 2022, doi: 10.1287/trsc.2022.1132.
- [35] J. Kennedy and R. Eberhart, "Particle swarm optimization," in *Proceedings of ICNN'95 - International Conference on Neural Networks*, Perth, WA, Australia, 1995, pp. 1942-1948 vol.4, doi: 10.1109/ICNN.1995.488968.
- [36] M. Dorigo, and L.M. Gambardella, "Ant colony system: a cooperative learning approach to the traveling salesman problem," *IEEE T. Evolut. Comput.*, vol. 1, no. 1, pp. 53–66, 1997, doi: 10.1109/4235.585892.
- [37] N. Christofides, A. Mingozzi, and P. Toth, "The vehicle routing problem" in *Combinatorial Optimization*, N. Christofides, A. Mingozzi, P. Toth, and C. Sandi, Eds. Chichester, USA: John Wiley & Sons, 1979, pp. 313–338.