

Competition between Dandelion and Prüfer encoded genetic algorithms for solving the clustered minimum routing tree problem

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REFERENCES

- [1] Benavoli, A.; Corani, G.; Mangili, F. Should we really use post-hoc tests based on mean-ranks? *J. Mach. Learn. Res.* **17** (2016), 152–161.
- [2] Cosma, O.; Pop, P.C.; Cosma, L. A novel memetic algorithm for solving the generalized traveling salesman problem. *Log. J. IGPL* **32** (2024), no. 4, 576–588.
- [3] Cosma, O.; Pop, P. C.; Cosma, L. A hybrid based genetic algorithm for solving the clustered generalized traveling salesman problem. *Lect. Notes Comput. Sci.* **14001** (2023), 352–362.
- [4] Cosma, O.; Pop, P. C.; Zelina, I. An effective genetic algorithm for solving the clustered shortest-path tree problem. *IEEE Access* **9** (2021), 15570–15591.
- [5] Cosma, O.; Pop, P. C.; Zelina, I. A novel genetic algorithm for solving the clustered shortest-path tree problem. *Carpathian J. Math.* **36** (2020), no. 3, 401–414.
- [6] Demange, M.; Monnot, J.; Pop, P.C.; Ries, B. On the complexity of the selective graph coloring problem in some special classes of graphs. *Theor. Comput. Sci.* **540–541** (2014), 82–102.
- [7] Demšar, J. Statistical comparisons of classifiers over multiple data sets. *J. Mach. Learn. Res.* **7** (2006), 1–30.
- [8] Dinh, T.P.; Thanh, B.H.T.; Ba, T.T.; Binh, L.N. Multifactorial evolutionary algorithm for solving clustered tree problems: competition among cayley codes. *Memetic Comput.* **12** (2020), no. 3, 185–217.
- [9] Feremans, C.; Labbe, M.; Laporte, G. Generalized network design problems. *Eur. J. Oper. Res.* **148** (2003), no. 1, 1–13.
- [10] Fidanova, S.; Pop, P.C. An improved hybrid ant-local search for the partition graph coloring problem. *J. Comput. Appl. Math.* **293** (2016), 55–61.
- [11] Fischetti, M.; Salazar-Gonzales, J.J.; Toth, P. A Branch-and-Cut Algorithm for the Symmetric Generalized Traveling Salesman Problem. *Oper. Res.* (1997) **45**, no. 3, 378–394.
- [12] Ghiani, G.; Improta, G. An efficient transformation of the generalized vehicle routing problem. *Eur. J. Oper. Res.* **122** (2000), 11–17.
- [13] Hanh, P.T.H.; Thanh, P.D.; Binh, H.T.T. Evolutionary algorithm and multifactorial evolutionary algorithm on clustered shortest-path tree problem. *Inf. Sci.* **553** (2021), 280–304.
- [14] Lin, C.-W.; Wu, B.Y. On the minimum routing cost clustered tree problem. *J. Comb. Optim.* **33** (2017), no. 3, 1106–1121.
- [15] Long, N.B.; Anh, D.T.; Ban, H.-B.; Binh, H.T.T. A multipopulation multitasking evolutionary scheme with adaptive knowledge transfer to solve the clustered minimum routing cost tree problem. *Inf. Sci.* **657** (2024), 119961.
- [16] Masone, A.; Nenni, M.E.; Sforza, A.; Sterle, C. The Minimum Routing Cost Tree Problem. State of the art and a core-node based heuristic algorithm. *Soft Comput.* **23** (2019), 2947–2957.

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- [17] Mestria, M.; Ochi, L.S.; de Lima Martins, S. GRASP with path relinking for the symmetric Euclidean clustered traveling salesman problem. *Comput. Oper. Res.* **40** (2013), no. 12, 3218–3229.
- [18] Myung, Y.S.; Lee, C.H.; Tcha, D.W. On the generalized minimum spanning tree problem. *Netw.* **26** (1995), 231-241.
- [19] Petrovan, A.; Pop, P.C.; Sabo, C.; Zelina, I. A Two-Level Hybrid Based Genetic Algorithm to Solve the Clustered Shortest-Path Tree Problem Using the Prüfer Code. *Lect. Notes Comput. Sci.* **13469** (2022), 323–334.
- [20] Petrovan, A.; Pop, P.C.; Sabo, C.; Zelina, I. Novel two-level hybrid genetic algorithms based on different Cayley-type encodings for solving the clustered shortest-path tree problem. *Expert Syst. Appl.* **215** (2023), 119372.
- [21] Picciotto, S. *How to encode a tree*. Ph.D. dissertation, University of California, San Diego, 1999.
- [22] Pintea, C.; Chira, C.; Dumitrescu, D.; Pop, P.C. Sensitive ants in solving the generalized vehicle routing problem. *Int. J. Comput. Commun. Control.* **6** (2011), no. 4, 734-741.
- [23] Pop, P.C.; Kern, W.; Still, G. A New Relaxation Method for the Generalized Minimum Spanning Tree Problem. *Eur. J. Oper. Res.* **170** (2006), 900-908.
- [24] Pop, P.C. *Generalized Network Design Problems, Modelling and Optimization*. De Gruyter, Germany, 2012.
- [25] Pop, P.C.; Matei, O.; Sabo, C.; Petrovan, A. A two-level solution approach for solving the generalized minimum spanning tree problem. *Eur. J. Oper. Res.* **265** (2018), no. 2, 478-487.
- [26] Pop, P.C.; Fuksz, L.; Horvat Marc, A.; Sabo, C. A novel two-level optimization approach for clustered vehicle routing problem. *Comput. Ind. Eng.* **115** (2018), 304-318.
- [27] Pop, P.C. The generalized minimum spanning tree problem: an overview of formulations, solution procedures and latest advances. *Eur. J. Oper. Res.* **283** (2020), no. 1, 1-15.
- [28] Pop, P.C.; Cosma, O.; Sabo, C.; Pop Sitar, C. A comprehensive survey on the generalized traveling salesman problem. *Eur. J. Oper. Res.* **314** (2024), no. 3, 819-835.
- [29] Sabo, C.; Teglas, B.; Pop, P.C.; Petrovan, A. Solving the Clustered Minimum Routing Tree Problem Using Prüfer-Coding Based Hybrid Genetic Algorithms. In Proc. of Hybrid Artificial Intelligent Systems (HAIS 2024), *Lect. Notes Comput. Sci.* **14857** (2025), 312-323.
- [30] Thang, T.B.; Binh, H.T.T. A hybrid multifactorial evolutionary algorithm and firefly algorithm for the clustered minimum routing cost tree problem. *Knowl.-Based Syst.* **241** (2022), 108225.
- [31] Thang, T.B.; Long, N.B.; Hoang, N.V.; Binh, H.T.T. Adaptive knowledge transfer in multifactorial evolutionary algorithm for the clustered minimum routing cost problem. *Appl. Soft Comput.* **105** (2021), 107253.
- [32] Thompson, E.; Paulden, T.; Smith, D.K. The Dandelion Code: A New Coding of Spanning Trees for Genetic Algorithms. *IEEE Trans. Evol. Comput.* **11** (2007), no. 1, 91-100.
- [33] Trung, T.B.; Thanh, L.T.; Hieu, L.T.; Thanh P.D.; Binh, H.T.T. Multifactorial evolutionary algorithm for clustered minimum routing cost problem. In Proceedings of the Tenth International Symposium on Information and Communication Technology, 170–177, 2019.

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