A novel decision support system for tourists green trip design optimization

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1 Introduction

During the visit, the tourists want to select a set of points of interest (POI) in the destination that correspond to their preferences. The choice must be made by specifying the most interesting places within a limited time. Then, they design a route between them while taking account the opening hours, the available time and the location. The purpose of this study is to provide a feasible and a personalized tourist plan with visiting the most valuable POI. Several existing web applications suggests a near optimal selection of POI and a route between them. The underlying question in this context is named tourist trip design problem (TTDP) [1].

The orienteering problem (OP) is used as the starting point for modeling tourist problem, which has to determine a tour that maximizes the total collected score by visiting a set of locations each with a score [2]. Well-known OP extension is the team orienting problem (TOP) where certain number of paths are allowed instead of only one [3].

The TOP with Time Windows (TOPTW) is one of variants of the TOP. The visit on each point is limited by a given time window and the trip is planned on multiple days. Recently, a comprehensive survey of TOPTW is presented by Gunawan et al. [4] and it has been used as a model in formulating TTDP.

As is well known, climate change has an effective impacts on tourism which required adaptation measures (shifting destinations, activities and seasons). The travel and tourism sector contributes a higher share to climate changes.

In this paper, we deals with the combinatorial optimization problem the team orienteering problem that will be applied to the TTDP. A general description of the problem is presented with the objective of finding the maximum of the sum of the collected profit by a fixed number of routes, by given a set of locations. Where each location have a score, a service time and a time window, while taking account climatic changes options. Considering the NP-hardness of the TOPTW, an improved meta-heuristic, based on an ant colony optimization and local search, are proposed to solve some well-known benchmark instances available in the literature.

2 Experimental results

We used the benchmark instances of Solomon and Cordeau et al.[5] to test the proposed algorithm. The number of nodes varies between 8 and 288. Computational experiments were conducted on a subset of characteristics (problem size, distribution of node location, and time windows) with m (number of stay days) $= \{1, 2, 3, 4\}$.

The performance of proposed algorithm is compared against the existing algorithms. Table 1 illustrates the computational results obtained through the proposed algorithm and reports the *gap* and the average computational time (CPU_{avg}) for each instance set.

From Table 1, we can point out that, for a considerable number of instances, IACO produced the best relative gap which is equal to 0,20% for the best known solution. We can also notice that the IACO is very competitive compared to the existing approaches. The proposed algorithm succeed to generate promising results in a challenging CPU time.

Instance Set	ACS		ILS		VNS		GRASP	-ELS	SA		GVNS		MA		IACA	
	rpe	cpu_{avg}	rpe	cpu_{avg}	rpe	cpu_{avg}	rpe	cpu_{avg}	rpe	cpu_{avg}	rpe	cpu_{avg}	rpe	cpu_{avg}	rpe	cpu_{avg}
m= 1																
rc100	0	143.21	2.92	0.23	0	65.21	0.33	1.99	0	22.19	1.88	9.80	0	1.59	-0.09	1.50
cr200	1.23	1544.55	3.43	1.63	0.07	869.41	1.37	8.21	0.96	50.25	2.53	16.01	-0.02	201.52	-0.31	97.73
pr01-pr10	1.05	1626.61	4.72	1.75	0	822.07	0.73	5.03	0.97	12.21	0.54	12.37	-0.02	485.98	-0.31	190.00
pr11-pr20	10.73	887.66	9.11	1.98	0.93	1045.93	1.70	7.90	3.25	162.40	2.71	24.22	0.39	903.08	0.12	178.33
m= 2																
rc100	0.38	1375.78	2.47	0.71	0.23	55.16	1.46	4.66	0.19	40.48	0.78	20.31	0	46.33	0	32.64
cr200	2.64	2342.72	4.08	2.20	0.43	804.82	0.59	17.14	1.18	80.10	1.62	12.76	-0.60	355.97	-0.54	132.71
pr01-pr10	2.35	1889.66	5.99	4.76	0.63	524.83	0.87	19.46	2.21	173.93	0.57	39.09	-0.44	1291.54	-0.35	323.95
pr11-pr20	4.79	2384.81	7.65	5.21	1.04	618.78	2.21	28.77	3.66	201.63	0.98	82.44	-0.24	2144.27	-0.20	801.27
m= 3																
rc100	1.19	1476.81	3.14	1.11	0.36	60.62	1.83	8.65	0.64	42.80	0.91	33.68	-0.01	104.73	-0.20	72.04
cr200	0.37	1607.85	1.37	1.73	0.04	404.01	0.06	8.34	0.20	58.98	0.25	7.41	-0.07	212.43	-0.05	11.56
pr01-pr10	3.01	2163.80	6.57	9.24	1.50	473.20	1.31	40.55	2.33	197.01	0.35	85.90	-0.33	1416.21	-0.53	202.11
pr11-pr20	5.19	2383.29	8.91	9.69	1.48	517.48	2.00	42.95	3.51	251.83	0.72	150.73	-0.71	2388.19	-89	467.74
m= 4																
rc100	0.92	1854.00	3.07	1.98	0.34	58.47	1.43	13.35	0.26	68.13	0.85	36.91	-0.24	57.66	-0.09	49.5
cr200	0	646.72	0	1.24	0	164.56	0	0.03	0	40.15	0	0.88	0	0.15	0	0.87
pr01-pr10	2.34	2447.70	6.63	14.07	1.40	403.17	1.42	45.75	1.76	255.57	0.60	127.33	-1.12	1807.40	-1.22	112.46
pr11-pr20	4.18	2583.50	7.16	13.74	0.90	408.01	1.20	65.33	2.57	283.98	0.64	232.64	-2.23	278.70	-2.33	137.21
Average	1.65	1401.79	3.38	3.09	0.36	375.62	0.74	22.60	0.96	88.30	0.87	64.34	-0.23	524.00	-0.31	85.13

TAB. 1 – Experimental results

3 Conclusion

In this paper, an improved ACO was proposed for the TOPTW that was applied the green TTDP. The computational results proved the efficiency of the proposed algorithm for TOPTW in comparison with the existing approaches in limited computation time. This is achieved by speeding up the evaluation of possible improvements and by better exploring the whole solution space. Furthermore, new best solutions are computed for the benchmark instances available in literature.

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