Shrinking fence search strategy for p-location problems

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Introduction

A special class of location problems in which given number of facilities are to be chosen to minimize the generalized objective function value is dealt with. The model extension enables to cover more demands of system users, which can arise almost simultaneously, and the nearest service center does not need to have sufficient capacity to service all the assigned.

Since the exact approach proved to be extremely time and memory demanding, we focus on a new strategy of heuristic solving the generalized p-location problem. Suggested strategy was verified in a computational study, in which real-sized problem instances will be solved. Since the optimal solution of all tested benchmarks is available, the accuracy of suggested algorithm is evaluated exactly.

Materials and method

The suggested strategy starts from a uniformly deployed set of p-location problems, which represents stakes of a hypothetical fence circling out a heard of good solutions of the problem. The links between the neighboring stakes are inspected and the resulting best found solutions represent the new stakes positions. After all links of the current fence are inspected, a new fence is formed by the new stakes positions and inspection of the new fence links can start. The new stakes, distance of which is less than a given threshold, are excluded from the new fence and the best found solution is updated, whenever a new good solution is met. The experiments are aimed at study of the algorithm efficiency. Efficiency can be defined by the difference between the objective function value of the optimal solution and the resulting solution produced by algorithm.

Results

Pop – max. number of population exchanges
Reg. – denotation of a benchmark derived from the Slovak self-governing regions
gap - relative deviation (%) of the output value from the optimal one
CT - computational time in seconds

Pop:	7		6		5		4	
Reg.	*gap*	*CT*	*gap*	*CT*	*gap*	*CT*	*gap*	*CT*
BA	0.0	0.11	0.0	0.07	0.0	0.09	0.0	0.08
BB	0.0	62.74	0.0	62.29	0.2	60.28	1.3	54.91
KE	0.0	12.21	0.1	11.92	0.3	11.48	2.4	10.51
NR	0.0	8.80	0.0	9.70	0.1	8.79	0.9	7.80
PO	0.0	94.11	0.0	94.90	0.4	88.41	3.6	92.56
TN	0.0	6.16	0.0	5.24	0.0	5.90	0.9	4.79
TT	0.0	5.45	0.0	5.13	0.0	5.49	0.9	4.76
ZA	0.0	11.09	0.0	13.85	0.0	13.79	0.2	10.15

Tab. 1.

Results

The experiments with the algorithm using the shrinking fence search strategy were organized so that the termination rule of maximal computational time was fixed 120 second and the maximal number Pop of population exchanges was step by step lowered.

Pop:	3		2		1	
Reg.	*gap*	*CT*	*gap*	*CT*	*gap*	*CT*
BA	0.3	0.08	4.2	0.07	14.2	0.06
BB	5.7	47.22	13.3	32.59	27.0	18.35
KE	5.0	8.98	11.3	6.75	18.2	3.78
NR	2.7	6.62	11.3	4.87	25.3	2.64
PO	9.0	64.56	17.6	45.54	32.5	25.78
TN	3.8	4.04	8.3	3.02	24.2	1.50
TT	3.3	4.03	5.6	2.86	15.2	1.47
ZA	2.3	8.74	8.3	6.51	24.8	3.32

Tab. 2.

Conclusion

In the presented computational study, we have shown that the algorithm is able to find the optimal solution of the problem in acceptably short computational time. Furthermore, we have studied the sensitivity of the algorithm to two parameters – maximal computational time and the number of population exchanges. Reported results performed with real-sized instances confirm the efficiency of suggested approach. Based on achieved results we can conclude that we have constructed a very useful tool for public service system designing, in which generalized disutility is applied.

Future research could be aimed at other strategies used in the path-relinking method and at studying their efficiency. Another research topic could consist in developing adaptive rules and various possible adaptively controlled reduction of the input uniformly deployed set of solutions.