Multi-Flux Strategic Oscillation Method for the Uncapacitated Facility Location Problem

Oualid GUEMRI[1], Saïd HANAFI[1], Fred GLOVER[2], Igor CREVITS[1]

[1] LAMIH, CNRS UMR 8201, Université de Valenciennes, France
{oualid.guemri, said.hanafi, igor.crevits}@univ-valenciennes.fr
[2] Leeds School of Business, University of Colorado, Boulder, CO 80309-0419, USA
fred.glover@colorado.edu

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The Uncapacitated Facility Location Problem (UFLP) consists of choosing a subset of facilities to be opened from a set of potential candidates, and to allocate each customer to an opened facility in order to meet the customers' demands. The objective is to minimize the overall cost including the costs of opening facilities and the costs of allocations. In this work we introduce a strategic oscillation method for solving the UFLP called Multi-Flux Oscillation Method (MFSO) and report experimentation that shows it outperforms all previous methods on a standard set of benchmarks for this widely-studied class of problems.

Strategic oscillation is a search technique used to traverse the search-region to reach and return from a boundary solution in a manner designed to discover interesting regions in the process [2]. The form of oscillation we use is a one-sided oscillation because all exploration takes place on one side (the feasible side) of the boundary between feasible and infeasible solutions. In each iteration, the algorithm starts from an initial feasible solution *x* and progressively improves it until a reaching a local optimum which in this context is also a boundary solution. Then, the algorithm iterates by alternately destroying the current solution (removing a subset of opened facilities) and then improving it again until a new boundary solution is found. We call our method the Multi-flux method because it is motivated as a simplified variant of the Multi-Wave algorithm of [3]. The process that performs improving moves is mediated by a special design incorporating horizontal phases and an active move record as in [3]. Fuller details of the method are given in [4] and will be exposed during our presentation.

To test the performance of our algorithm we use the benchmark data set of [5] with instances varying from 500 facilities and 500 customers to 750 facilities and 750 customers (which are the most challenging ones, which can be upload from http://resources.mpi-inf.mpg.de/departments/d1/projects/benchmarks/UflLib/). In Table 1, our reported results are compared with the results of the most effective methods of the literature token from [1]. These methods are: (1) The Tabu Search (**TS**), (2) The Lagrangian based method (**CLM**), (3) The Granular Tabu Search (**GTS**), (4) The hybrid multi-start heuristic (**Hybrid**), which combines advantages of several methods such as scatter search, tabu search and genetic algorithm, (5) The hybrid of Trajectory Search and VNS, called the Multiple Trajectory Search (**MTS**), (6) The discrete Unconscious Search (**US**).

Regarding Table 1, our algorithm was able to reach all best known solution found by the most effective methods in the literature, and to obtain a new best known solution for the instance *500-asym-A*, thus outperforming all previously proposed methods. Furthermore, Table 2 shows that our algorithm has a competitive computing time comparing to the literature methods. The promising results whereby our basic strategic oscillation method outperforms the most effective previous methods in the literature motivates us to apply this algorithm and more sophisticated variants derived from [3] to other location problems such as the Capacitated Facility Location Problem.

Instance	TS (1)	GTS (3)	CLM (2)	Hybrid(4)	MTS (5)	US (6)	**MFSO**
500-sym-A	**511180.4**	511383.6	511487.2	511196.4	511188.8	**511180.4**	**511180.4**
500-sym-B	**537912.0**	538480.4	538685.8	**537912.0**	**537912.0**	**537912.0**	**537912.0**
500-sym-C	**621059.2**	621107.2	621172.8	**621059.2**	**621059.2**	**621059.2**	**621059.2**
500-asym-A	511140.0	511251.6	511393.4	511145.0	511137.8	511137.4	***511136.4****
500-asym-B	**537847.6**	538144.0	538421.0	537863.4	**537847.6**	**537847.6**	**537847.6**
500-asym-C	**621463.8**	621811.8	621990.8	**621463.8**	**621463.8**	**621463.8**	**621463.8**
750-sym-A	763693.4	763830.8	763978.0	763706.6	763708.8	**763684.8**	**763684.8**
750-sym-B	**796571.8**	796919.0	797173.4	796632.2	**796571.8**	796576.8	**796571.8**
750-sym-C	**900158.6**	901158.4	900785.2	900272.0	**900158.6**	**900158.6**	**900158.6**
750-asym-A	763717.0	763836.6	764019.4	763731.2	763735.8	**763712.4**	**763712.4**
750-asym-B	**796374.4**	796859.0	796754.2	796396.8	**796374.4**	**796374.4**	**796374.4**
750-asym-C	**900193.2**	900514.2	900349.8	**900193.2**	**900193.2**	**900193.2**	**900193.2**
#BKS	**9/12**	**0/12**	**0/12**	**4/12**	**8/12**	**10/12**	**12/12**

Table 1. – MFSO results Vs. The literature results

	TS (1)	GTS (3)	CLM (2)	Hybrid(4)	MTS (5)	US (6)	**MFSO**
Average	81.15	-	1359.87	58.56	55.03	11.34	**16.76**

Table 2. – Comparison of CPU times (In seconds)

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