**SOLVING THE SINGLE SOURCE CAPACITATED FACILITY LOCATION PROBLEM**

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**ABSTRACT**

We devise an efficient algorithm for solving the single source capacitated facility location problem. We concentrate on problems that are very difficult for standard integer programming optimizers to solve in a reasonable amount of computation time.

**INTRODUCTION**

The classical single source capacitated facility location problem (SSCFLP) has numerous applications ranging from distribution/facility location to telecommunications network design. Of course, SSCFLP belongs to the set of NP hard problems. Clever heuristics exist that generate good feasible solutions in a fraction of the time required by “off the shelf” optimizers such as LINDO or CPLEX. However, for large, **hard** problems on the order of 20 or more facilities and 100 or more customers, obtaining an optimal solution could take days for such optimizers. One reason for this is that (as opposed to the classical facility location problem) all variables are required to be binary.

We incorporate a number of tightening procedures that may be used when one has a “good” feasible solution to SSCFLP with corresponding objective value Z\*. With a good solution in hand, additional tightening may take place by solving a number of linear programs (LP’s) where, in one instance, we maximize (and then minimize) the sum of facilities open subject to the SSCFLP constraint set and the constraint that the objective function must not exceed Z\*. Another LP tightening includes solving an LP for each potential facility with the objective of determining a lower (upper) bound on the minimum (maximum) flow through an open facility subject once again to the objective function not exceeding Z\*. Other tightenings include finding upper and lower bounds on the total shipment costs in an optimal solution as well as upper and lower bounds on the total fixed costs in an optimal solution. These tightenings are cumulative in nature and may continue to be applied in sequence until no further tightenings are indicated.

An interesting property of the SSCFLP is that if all facility location variables are set to 0 or 1, the resulting problem is a generalized assignment problem (GAP). In this paper we capitalize on this property. As is well known, certain classes of GAP problems can be difficult to solve using “off the shelf” software. A special purpose algorithm for the GAP is used that utilizes lagrangean relaxation instead of linear programming as the primary solver for branch-and-bound candidate problems. We combine this approach with a search of the facility-variable-space of SSCFLP in order to identify the set of candidate problems which are, in effect, GAP problems. The collection of GAP problems resulting from the successive tightening described above are then solved with the special purpose GAP algorithm.

The order in which the set of GAP problems is solved can lead to decreased computation time. For example, suppose an improved feasible solution to SSCFLP with objective value Z^ < Z\* is found while solving an individual GAP problem. Then, if any remaining GAP problems have a relaxation value >=Z^, they may be discarded. We conclude by presenting computational experience.