

Eliminating sets from consideration

Suppose that P_j is a lower bound on the cost of all feasible solutions which include set j .

If P_j exceeds the cost of a known feasible solution, then set j can be eliminated from any further consideration... it cannot be included in any optimal solution.

How can we compute such a lower bound?



If we add the restriction $X_j=1$ to the set covering problem, then the optimal solution of the Lagrangian relaxation (with the added restriction) will be

$$P_j = \begin{cases} \Phi(\lambda) + \bar{c}_j & \text{if } X_j=0 \text{ in the solution of the} \\ & \text{current Lagrangian relaxation} \\ \Phi(\lambda) & \text{if } X_j=1 \text{ in the solution of the} \\ & \text{current Lagrangian relaxation} \end{cases}$$

reduced cost of X_j

This gives us a lower bound on the cost of all feasible solutions of the set covering problem which contain set j .

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If any points remain uncovered, our heuristic adjustment procedure must

- select the next point to be covered
- select one of the sets covering this point

After all points are covered, any superfluous set (whose removal does not leave any point uncovered) is removed from the solution.

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Selecting a set to be added:

- Add the set which covers the point at lowest cost (Beasley)
- Consider as candidates the K least-cost sets covering the point; add the set which has the lowest "reduced cost".
- Consider as candidates the K least-cost sets covering the point; recompute the "reduced cost" with zero assigned to Lagrangian multipliers of points already covered.

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Consider a modification of our original problem, in which the constraint $X_j=1$ is added.

Consider further the Lagrangian relaxation of that problem (in which all but the constraint $X_j=1$ is relaxed).

If we use the same values of the Lagrangian multipliers as those used in the relaxation of the original problem, the Lagrangian relaxation of the modified problem is easily solved:

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Heuristic Adjustment Procedures

Each time we evaluate $\Phi(\lambda)$, i.e., solve a Lagrangian relaxation, we obtain a solution which in general leaves some points uncovered and/or covers some points more than once.

By adding &/or removing sets, we can perhaps obtain a good solution of the original problem.

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Selecting an uncovered point

- select one of the uncovered points at random
- select the uncovered point having the largest Lagrangian multiplier
- select the point having the smallest number of potential covering sets

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