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Basics of Redundancy and Solutions in Linear Programming Problems

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ABSTRACT: Many researchers have proposed different approaches and different solutions for redundancy and for solving linear programming problems. In this paper various approaches and solutions are presented.

I. INTRODUCTION

This standard linear programming model is an indispensable tool in today's manufacturing environment. The simplex method provided the first effective solution technique, but numerous other algorithms have been proposed. For example, feasible direction methods have been proposed by Brown and Koopmans. Murty and Fathi also proposed a feasible direction method; the method begins with a feasible basic vector for the problem, and constructs a profitable direction to move using the updated column vectors of the non-basic variables eligible to enter this basic vector [2]. It then moves in this direction as far as possible, while retaining its feasibility. This move, in general, takes it through the relative interior of a face of the set of feasible solutions. The final point obtained at the end of this move will not in general be a basic solution. Using the method then constructs a basic feasible solution at which the objective value is better than, or the same as that of. The whole process is repeated with the new basic feasible solution [5].

II. PROPOSAL

Optimum Solution

Any feasible solution which optimizes (maximizes or minimizes) the objective function of a General LPP is called an optimum solution to the General LPP [2].

Improved Basic Feasible Solution

Let x_b and x_b' be two basic feasible solutions to the standard LPP. Then x_b' is said to be an improved basic feasible solution, as compared to x_b , if x_b' where x_b' is constituted of cost components corresponding to x_b [3].

In formulating a mathematical programming problem we could try to avoid the inclusion of redundancy. How costly it is to prevent redundancy, will depend largely on the kind of problem being formulated, the method used to solve it, the objective of the problem and, most importantly, on the specifics of the practical context of the problem [4]. Since at this stage the benefits of excluding redundancy are also problem dependent, there is very little to say definitively about how much it is worth spending on preventing redundancy in formulating a mathematical programming problem.

In solving an LPP, we have to include all possible constraints that will increase the number of iterations and computational work. In most of the large scale LP problems, only a relatively small percentage of constraints are binding at the optimal solutions [8].

Linear programming is the name of a branch of applied mathematics that deals with solving optimization problems of a particular form. Linear programming problems consist of linear cost function (consisting of a certain number of variables) which is to be minimized or maximized subject to a certain number of constraints. The constraints are linear inequalities of the variables used in the cost function. The cost function is also sometimes called the objective function. Linear programming is closely related to linear algebra; the most noticeable difference is that linear programming often uses inequalities in the problem statement rather than equalities [6].

Once a problem is formulated, most of the remarks mentioned above are true as well, but we have some additional information with which to work. We now have three clear options whose costs can be objectively calculated: (i) do nothing, (ii) identify redundancy, (iii) identify and remove redundancy. The options are listed in the increasing order of cost, but any more precise determination of the costs requires a more precise description of the mathematical programming problem, and

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the kind of redundancy to be identified[6].

The removal of redundancy in (iii) is not necessarily as easy an operation as it seems. For example, if a constraint in a linear programming problem is determined to be redundant and its associated slack variable happens to be non-basic in the current extreme point solution, we have to perform a simplex iteration to be able to remove the redundant constraint.

A new comprehensive implementation of a primal-dual algorithm for linear programming is described. It allows for easy handling of simple bounds on the primal variables and incorporates free variables. A variety of computational issues concerning the primal-dual implementation and barrier methods for linear programming in general are discussed. In certain aspects, this method for obtaining feasibility is equivalent to Newton's method was showed. This demonstrates that the method is, in some sense, the natural way to reduce infeasibility. The role of the barrier parameter in computational practice is studied in detail, by Lustig.

Theorem

If there is a unique solution which maximises the objective function (subject to the constraints) then it must be a basic feasible solution. Note: With n choice variables and m constraints there will be $n+mC_n$ basic solutions e.g. for $n=6$ $m=10$ there are 8008 basic solutions. We need an efficient search procedure. This is what the [2,5] simplex algorithm provides. In a basic solution, $n-m$ of the zero-valued variables are considered non-basic variables and the remaining m variables are considered basic variables.

A linear program is unbounded if the optimal solution is unbounded, i.e., it is either. Note that the feasible region may be unbounded, but this is not the same as the linear program being unbounded

The constraint selection technique begins by solving a sequence of subproblems using only a few of the original constraints. If the solution obtained to this sub problem satisfies the remaining constraints, it is optimal for the original LP. Otherwise, additional constraint must be incorporated in a larger sub problem until a solution is obtained which satisfies all the original constraints.

Feasible Solution Any solution to a General LPP which also satisfies the non-negativity restrictions of the problem is called a feasible solution to the **Theorem**

Given the linear programming problem P , where A is an $m \times n$ matrix of rank m . If there is any feasible solution, then there is a basic feasible solution. If there is any optimal solution, then there is a basic optimal solution.

Proof: Suppose that a feasible solution exists. Choose any feasible solution among those with the fewest non-zero components. If there are no non-zero components, then $x = 0$ and x is a basic solution by definition. Otherwise, take the index set $J := \{j_1, j_2, \dots, j_r\}$ with elements corresponding to those $x_{j_i} > 0$. Then if we denote the corresponding columns by $\{a(j_1), a(j_2), \dots, a(j_r)\}$ there are two possibilities:

1. The set of columns is linearly independent. In this case, we certainly have $r \leq m$. If $r = m$ the corresponding solution is basic and the proof is complete. If $r < m$ then, since A has rank m , we choose $m-r$ vectors from the remaining $n-r$ columns of A so that the resulting set of m column vectors is linearly independent. Assigning the value zero to the corresponding $m-r$ variables yields a (degenerate) basic feasible solution.

III. CONCLUSION

Many proposed approaches and different solutions for redundancy and for solving linear programming problems were reviewed.

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