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A NOTE ON MODELING MULTIPLE CHOICE REQUIREMENTS FOR SIMPLE MIXED INTEGER PROGRAMMING SOLVERS†

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Scope and Purpose—In the great majority of real-life mixed integer programming models most of integer variables represent some multiple choice requirements. A multiple choice requirement is usually modeled with a generalized upper bound on a set of zero–one variables thus creating the so-called Special Ordered Set (SOS). During the past decade powerful microcomputers with friendly optimization software have become standard productivity tools for businessmen and other decision makers. Unfortunately, the branch and bound algorithms implemented there, usually, do not support the special treatment of SOS constraints. Therefore, one may face enormously long computation time while solving quite small problems including several multiple choice requirements. To overcome these difficulties we propose another algebraic model of multiple choice requirements. While using the proposed modeling technique, the standard branch and bound algorithm generates a balanced branching on the set of options included in the multiple choice requirement. It results usually in a significant shortening of the solution process.

Abstract—This note introduces the Special Ordered Inequalities (SOI) as a new technique for integer programming modeling of multiple choice requirements and piecewise linear functions. The standard modeling technique based on the use of Special Ordered Set (SOS) structure requires a branch and bound solver to be armed with the special tools for SOS processing. Otherwise, the standard branching rule applied on individual SOS variables may lead to enormously long computation process thus making impossible to solve quite small problems in a reasonable time. The proposed SOI modeling technique allows us to eliminate the necessity of the special branching rule for handling SOS structure. The standard branching on individual variables of SOI is equivalent to the special SOS branching. Thus the proposed modeling technique seems to be very attractive for users of simple mixed integer programming solvers as well as for those who want to build solver independent mathematical programming models.

1. INTRODUCTION

In the great majority of real-life mixed integer programming models most of integer variables represent some multiple choice requirements [1]. There is a variety of applications leading to models with this structure (cf. Martin and Sweeney [2]; Hummeltenberg [3] and references therein). In particular, one may consider multi-item production scheduling [4,5,6], sales resource allocation [7], menu planning [8], and catalog space planning [9]. A multiple choice requirement is usually modeled with a generalized upper bound on a set of zero–one variables [10], thus creating the so-called Special Ordered Set (SOS). For instance, the multiple choice requirement

$$x \in \{a_1, a_2, \ldots, a_r\} \tag{1}$$

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