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Discrete Optimization

A chance constraints goal programming model for the advertising planning problem

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Abstract

This paper presents a model which has been designed to decide the number of advertisement in different advertising media and the optimal allocation of the budget assigned to the different media. The main objective of this problem is to maximize the reach to the desired section of people for different media within their maximum allowable budget without violating the max and min number of advertisement goals. The media have been considered as different newspapers and different channels in Televisions. Here in this article the model has been formulated in such a way that the advertisement should reach to those who are suitable for the product instead of going to those section who are not considered suitable for the product as well. A chance constrained goal programming model has been designed after considering the parameter corresponding to reach for different media as random variables. The random variables in this case has been considered as values which have known mean and standard deviations. A case for an upcoming institution who are interested to advertise for its two years Post Graduate Diploma in Management (PGDM) programme to the different newspapers and television channels has been designed to illustrate the solution methodology.

Keywords: Advertising and media planning; Stochastic programming; Multi-objective decision making; Goal programming

1. Introduction

The goal programming (GP) model is one of the well-known multi-objective mathematical programming models. This model allows to take into account simultaneously several objectives in a problem for choosing the most satisfactory solution within a set of feasible solutions. More precisely, the GP designed to find a solution that minimizes the deviations between the achievement level of the objectives and the goals set for them. In the case where the goal is surpassed, the deviation will be positive and in the case of the underachievement of the goal, the deviation will be negative. First developed by Charnes et al. (1955) and Charnes and Cooper (1961) then applied by Lee (1973) and Lee and Clayton (1972), the GP model gained a great deal of popularity and its use has spread in diversified field such as management of water basins, management of solid waste, accounting and financial aspect of stock management, marketing, quality control, human resources, production, transportation and site selection, space studies, telecommunications, agriculture and forestry and aviation.

The general form of the GP model is

$$\begin{aligned} &\text{Minimize} \quad \bar{a} = \{g_1(\bar{n},\bar{p}), g_2(\bar{n},\bar{p}), \ldots, g_k(\bar{n},\bar{p})\} \\ &\text{Such that} \quad f_i(\bar{x}) + n_i - p_i = b_i, \quad \bar{x},\bar{n},\bar{p} \geqslant \mathbf{0}, \end{aligned}$$

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where $g_k(\bar{n}, \bar{p})$ is a linear function of the deviational variables. The dimension of $\bar{a}$ represents the number k of the preemptive priority levels. b_i represents the level of aspiration associated with the objective $f_i(\bar{x})$. The variables n_i and p_i indicate the negative and positive deviations respectively of the achievement level $f_i(\bar{x})$ from aspiration level.

The goal or aspiration levels assigned to the various objectives can be probabilistic where the decision maker does not know its value with complete certainty. The first formulation of the stochastic GP model goes back to the late 1969s with Contini's works (1968). He considers the goal as uncertain variables with a normal distribution. Stancu-Minasian (1984) and Stancu-Minasian and Giurgiutiu (1985) present a synthesis of methodologies used in multiple objective programming in a stochastic contest. Several other techniques have been proposed to solve the SGP model. The most popular technique is a chance constrained programming developed by Charnes and Cooper (1952, 1959, 1963). Belaid et al. (2005) have exploited the concept of the satisfaction function to explicitly integrate the decision maker's preferences in the stochastic goal programming model.

Quantitative modeling used in the literature to solve media budget allocation problems are classified as simulation, heuristic or multi-criteria decision making. Some studies are available on conflicting media planning issues in terms of customer relationships, advertising effects, and resource allocation using analytical hierarchy process and goal programming simultaneously in order to provide more systematic solution in real world settings.

Multi-criteria decision making is a useful tool which can simultaneously consider various aspects of media selection and planning problems to obtain satisfactory solution of the original problem. Moynihan et al. (1995) and Fructhter and Kalish (1998) contended that the mathematical requirements of the MCDM model for media selection force the media planner to create an artificial structuring of the media selection criteria. Charnes et al. (1968) introduced a GP model for media selection that provides significant improvement over the earlier linear programming model. The model was designed to address problems associated with the critical advertisement measurement of frequency and reach. The objectives considered include the percentage reach and frequency of appearance in different types of media aimed at different segments of the market at different time periods, and cost of the advertising. Lee (1972) considers a similar problem and also use the goal programming approach. Keown and Duncan (1979) developed an integer goal programming model to solve media selection problems and improved upon sub-optimal results produced by linear programming and non-integer GP models. Mihiotis and Tsakiris (2004) reviewed the recent study to advertisement planning. The study discussed the best possible combination of placements of commercial (channel, time and frequency) with the goal of the highest rating subject to constrained advertisement budgets. Kwak et al. (2005) has presented a case study that considers two options: industrial and consumer products. In order to resolve the strategic decision making about dual market high technology products, a mixed integer goal programming model is developed to facilitate the advertising media selection process. Abratt (1996) has studied a dual market problem associated with hi-tech computer product. Lee and Kwak (1999) has developed an information resource planning using an AHP based goal programming model. De Kluyver (1978) proposed the more realistic use of hard and soft constraints for linear programming models used in media selection.

In the present article, the problem of selecting optimum number of advertisement in different media has been considered. It is desired to find the number of advertisements to be given in different media, within the allowable budget assigned for different media, in order to maximize the desirable reach to the target audiences. Here the media have been considered as the different newspapers and the different channels of television. The cost aspects for the different pages of the newspapers and time allocation for the different periods of time in a day of the TV channels have been given due consideration. The problem has been formulated as a multi-objective chance constraints goal programming problem. Here in this article the model has been formulated in such a way that the advertisement should reach to those who are potential for the product instead of going to those section who are not potential for the product as well. The problem has been modeled as a chance constrained goal programming problem after considering the reach (to the target audiences) parameters as the random variables. It has been assumed that the random variables corresponding to the reach (for different media) is a quantity with known mean and standard deviations. The parameter corresponding to the reach can be obtained by finding the ideal solutions and the trend of which the parameter varies.

Mathematical model formulations for both the newspaper and magazines and the televisions have been discussed in Section 2. Solution methodology for the multi-objective chance constraints programming problem has been given in Section 3. A case for an upcoming academic institution for its two years Post Graduate Diploma in Management Programs has been designed in Section 4 to illustrate the solution methodology. Concluding remarks are made in Section 5.

2. Model formulation

The media considered in this paper are different types of newspapers and different channels of Television. In the next two section the model formulation for the different types of media have been considered.