Journal of Statistics Applications & Probability
An International Journal

http://dx.doi.org/10.18576/jsap/060316

New Randomized Response Procedure for Finding Optimal Solution Using Branch and Bound Method

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Received: 12 Jun. 2017, Revised: 21 Sep. 2017, Accepted: 14 Oct. 2017
Published online: 1 Nov. 2017

Abstract: The crux of this paper is to consider a randomized response model using stratified random sampling based on Singh and Gorey (2017). In this paper the problem of optimal allocation in stratified random sampling where randomized response technique is used in presence of non response. The problem is formulated as a Nonlinear Programming Problem (NLPP) and is solved using Branch and Bound method. Also the results are formulated through LINGO.

Keywords: Randomized response technique, Optimum allocation, Stratified random sampling, Dichotomous population, Sensitive attribute, Branch and Bound method.

1 Introduction

The most serious problem in studying certain social problems that are sensitive in nature (e.g.drunk driving, use of marijuana, tax evasion, illicit drug use, induced abortion, shop lifting, child abuse, family disturbances, cheating in exams, HIV/AIDS and sexual behaviour induced abortion, etc.) is lack of reliable measure of their incidence or prevalence. Thus to obtain trustworthy data on such confidential matters, especially the sensitive ones, instead of open surveys alternative procedures are required. Such an alternative procedure known as randomized response technique (RRT) was first introduced by Warner (1965). It provides the opportunity of reducing response biases due to dishonest answers to sensitive questions. As a result, the technique assures a considerable degree of privacy protection in many contexts. Warner (1965) himself pointed out how one may get a biased estimate in an open survey when a population consists of individuals bearing a stigmatizing character A or its complement , which may or may not also be stigmatizing. Theoretical details for this model were given by Greenberg et al. (1969). This technique has generated much interest in the statistical literature since the publication of Warners (1965) randomized response (RR) model. Subsequently, several other workers have proposed different RR strategies for instance, see the review oriented references like Fox and Tracy (1986) and Tarray (2016). Some times in survey sampling certain amount of information is known about the elements of the population to be studied. For instance, information may be available on the geographical location of the area, e.g. if it is an inner city, a suburban or a rural area. Census information will provide a wealth of other information about the area, for instance, its population at the previous census, its rate of population change, the proportion of its population employed in manufacturing, or the proportion of its population with different origins. Supplementary information of this type can be used either at the design stage to improve the sample design, or at the analysis stage to improve the sample estimators, or both the essence of stratification is the classification of population in to sub-population or strata, based on some supplementary information and then the selection of separate samples from each of the strata. The benefits of stratification derive from the fact that the sample sizes in the strata are controlled by the sampler, rather than being randomly determined by the sampling process after the strata sample sizes are made proportional to the strata population sizes.

For the sake of completeness and convenience to the readers, we have given the descriptions of Singh and Gorey (2017) model.

The randomized response R_i device consists of a deck having three types of cards in Singh and Gorey (2017) model . In stratum i, p_{1i} proportions of cards carry the statement I belong to the sensitive category A, p_{2i} $(p_{1i} \neq p_{2i})$the proportion

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