Privacy Protection in Optional Randomized Response Surveys for Quantitative Characteristics

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Abstract

A survey regarding sensitive or stigmatizing issues often bears a challenge as most respondents either deny answering direct queries or hide true response. Warner (1965) designed an ingenious device by a dint of a probabilistic procedure for estimating qualitative sensitive population proportion, called randomized response (RR) device and the novel technique is well known as randomized response technique (RRT). Greenberg et al. (1971) used the RR technique in quantitative attributes. An issue often raised with RRT is that some are more willing to answer directly rather than compulsory RR as the perception of sensitivity may not be same for all. Considering this fact, Chaudhuri and Mukerjee (1985) developed the optional randomized response technique (ORRT) which was restricted to Simple Random Sampling (SRS) design only. Later Chaudhuri and Saha (2005), Pal (2008) extended their work for unequal probability sampling. We discuss here about the privacy protection measure dealing with quantitative sensitive issues like alcohol consumption, earning through gambling, income etc. The literature is an extension of Chaudhuri and Christofides (2013) aiming at to develop how privacy is protected while applying ORRT into quantitative sensitive issues. In this paper we theoretically develop few well known RRTs for quantitative case in ORRT context first and unbiased estimators with its variance estimators are obtained. Protections of privacy of the proposed techniques are measured theoretically.

Key words: Protection of privacy, randomized response, sensitive issues, quantitative characteristics, unequal probability.

1. Introduction

Enumeration related to sensitive issues like alcohol consumption, drug addiction etc is usually impossible by direct survey method because the respondents may fear oppression if they disclose their actual status. Randomized response technique (RRT) refers to a widely used method for estimating population proportion or others which is related to a sensitive characteristic avoiding the direct queries. Warner (1965) developed the novel RRT technique. Erikson (1973) presented the estimation of total stigmatizing real variable like amount earns through gambling, alcohol consumption etc. Chaudhuri and Mukherjee (1985, 1988) illustrated optional randomized response technique (ORRT) while respondents were selected by SRS with replacement only. Later Arnab (2004) and Chaudhuri and Saha (2005) extended the theory in unequal probability design. Chaudhuri (2011), Chaudhuri and Christofides (2013) provide extensive developments in RRT, also in ORRT along with protection of privacy measures. For further references and recent developments, please refer to a monograph edited by Chaudhuri, Christofides, Rao (2016). Full ORRT and partial ORRT are

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