



Interfaces with Other Disciplines

Monte Carlo analysis of estimation methods for the prediction of customer response patterns in direct marketing

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ABSTRACT

In direct marketing, customers are usually asked to take a specific action, and their responses are recorded over time and stored in a database. Based on the response data, we can estimate the number of customers who will ultimately respond, the number of responses anticipated to receive by a certain period of time, and the like. The goal of this article is to derive and propose several estimation methods and compare their performances in a Monte Carlo simulation. The response patterns can be described by a simple geometric function, which relates the number of responses to elapsed time. The “maximum likelihood” estimator appears to be the most effective method of estimating the parameters of this function. As we have more sample observations, the maximum likelihood estimates also converge to the true parameter values rapidly.

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1. Introduction

“Direct marketing” is an interactive marketing system that uses various channels to target potential customers – one-on-one. It attempts to send its message directly to the customers without the use of *intervening* media. The most popular form of communication is direct mail, which is also referred to as “ad-mail” and may involve bulk mail. Other direct marketers also use e-mail marketing, telemarketing, broadcast faxing, door-hangers, and coupons.

In direct marketing, customers are usually asked to take a specific action which is quantifiable, such as calling a toll-free telephone number, clicking a link to a website, ordering a product online with a promotional code, redeeming a discount coupon, or returning a prepaid postcard. Due to this aspect of direct marketing, the customers’ responses are tractable and measurable, and their activities are usually stored in a database. Using the customers’ response records currently available, we may estimate the expected number of responses or the overall response rate, and use such information in making important managerial decisions.

Suppose, for example, that a store manager mailed out discount coupons for a digital camera as a promotional tool to n customers k weeks ago. Since then, the manager has recorded the number of coupons that have been redeemed in each week. Based on the weekly response records $\mathbf{x} = \{x_1, x_2, \dots, x_k\}$ for the past k weeks, the manager wants to estimate the total number of coupons that will be redeemed ultimately or by a certain point in time. If the manager underestimates the total demand, the promotional items in stock could be run out and the store may suffer the loss of customer good will or extra ordering and shipping costs (Bijvank

and Vis, 2011). On the other hand, over-stocking the promotional items in the first place may result in higher inventory, maintenance, and salvage costs.

Consider another example in which, as a part of its annual fund-raising campaign, a university sent out n donation request letters with prepaid post cards to its n alumni. Based on the number of daily or weekly replies $\mathbf{x} = \{x_1, x_2, \dots, x_k\}$ for the past k time periods, the alumni office wants to estimate the number of alumni who will participate in the fund-raising campaign by a certain point in time. The admissions office at the same university is in the similar situation when they mailed out informational brochures with reply cards to n high school seniors. We have the same type of estimation problem with mail or online survey forms, discount coupons in Sunday newspaper, solicitation letters for credit card or mortgage applications, membership renewal requests, or e-mail advertisements with online coupons.

Recently, Bose and Chen (2009) reviewed various quantitative models for direct marketing, including the problem of estimating consumer response patterns, from a systems perspective. The problem of predicting the number of respondents can be also treated as a forecasting problem as in Fildes et al. (2008). The response rates in a specific field have been analyzed by various researchers – in operations management by Frohlich (2002) and in human resource management and organizational behavior by Roth and BeVier (1998). Various factors that could increase the response rate in mail survey were analyzed by Bruvold and Comer (1990).

In the paper, we (i) develop a geometric response model, (ii) consider various methods of estimating its parameter values, and then (iii) compare their performances in a Monte Carlo simulation. Amemiya (1976) previously compared the efficiencies of the maximum likelihood estimator, minimum Chi-square estimator,

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