

Donor Segmentation: When Summary Statistics Don't Tell the Whole Story

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Available online 10 July 2013

Abstract

Funding pressures amidst the slow economic recovery from the late-2000's recession have forced universities, as well as other not-for-profit organizations, to increase the volume and sophistication of their direct marketing activities. The efficiency of direct marketing strategies is linked to an organization's ability to effectively target individuals. In this paper, we present a finite-mixture model framework to segment the alumni population of a university in the midwestern United States.

Much of the research on customer segmentation summarizes response data (*e.g.*, purchase and contribution histories) *via* recency, frequency and monetary value (RFM) statistics. Individuals sharing similar RFM characteristics are grouped together; the rationale being that the best predictor of future behavior is past behavior. Summary statistics such as RFM, however, introduce aggregation bias that mask the dynamics of purchase/contribution behavior. Accordingly, we implement latent-class segmentation models where alumni are classified based on how an individual's contribution sequence compares to those of other individuals. The framework's capability to process contribution sequences, *i.e.*, longitudinal data, provides fundamental new insights into donor contribution behavior, and provides a rigorous mechanism to infer and segment the population based on unobserved heterogeneities (as well as based on other observable characteristics). Specifically, we analyze Markov mixture models to segment alumni based on contribution-behavior patterns, under the assumption of serially-dependent contribution sequences. We use the expectation–maximization algorithm to obtain parameter estimates for each segment. Through an extensive empirical study, we highlight the substantive insights gained through the processing of the full contribution sequences, and establish the presence of three distinct classes of alumni in the population (each with a discernible contribution pattern). The proposed framework, collectively, provides a basis to tailor direct marketing policies to optimize specific performance criteria (*e.g.*, profits).

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Keywords: Customer segmentation; Non-profit fundraising; Direct mail; Expectation–maximization (EM) algorithm; Customer-based analysis

Introduction

Of the \$28 billion raised by colleges and universities in 2010, 43% (\$12.02 billion) came from contributions by individuals (Council for Aid to Education 2011). Understanding the dynamics that drive individuals' contributions is vital to university fundraising efforts. This is particularly important in the current economic environment. In 2009 and 2010, colleges and universities in the United States saw record decreases in alumni contributions in 50 years of record-keeping, with drops of 6.2% and 11.9%, respectively (Hall and Joslyn 2011). Motivated, in

part, by sharp declines in endowment income as a result of the global economic crisis, and increased competition from other nonprofits for the same pool of dollars, universities have worked to increase the volume and sophistication of their fundraising efforts.

Studies on university fundraising/alumni giving have typically aimed to identify (statistically significant) traits associated with giving, such as demographic and socio-economic characteristics (*e.g.*, Okunade 1996), and to examine alumni/donor motivations to give, such as awareness of the need for financial support and prestige/recognition (*e.g.*, Gaier 2005; Holmes 2009). Moreover, most models in this literature study the contemporaneous relationship between dependent variables and one or more independent variables (*i.e.*, they are static), and thus ignore the dynamics of alumni contribution behavior. In the related direct marketing optimization literature, studies consider the dynamics of consumer

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response/purchase behavior (e.g., Gonul and Shi 1998; Jonker, Piersma, and Van den Poel 2004; Simester, Sun, and Tsitsiklis 2006) with the aim to improve mailing strategies to different segments. These dynamic segmentation models are usually formulated as *latent change* models that describe how segment size and membership evolve over time, with segments defined based on RFM statistics.

This study contributes to the fundraising/alumni-giving literature by analyzing dynamic models of contribution behavior, and to the direct marketing segmentation literature by formulating *manifest change* models where segment membership is assumed to be stable, and where manifested changes, *i.e.*, variability in the individual contribution sequences, are attributed to the characteristics that define the stable segments. This supports the identification of systematic, but unobserved, differences between individuals, and enables optimization of direct marketing policies for the ensuing segments. Finally, the segmentation models we develop provide a rigorous framework to exploit longitudinal data, which addresses the aggregation bias introduced when using RFM statistics to segment the population. More importantly, these models allow for insights about the evolution of contributions.

Specifically, we employ finite mixture models as a framework to analyze alumni contribution behavior. The underlying assumption in this framework is that the population is comprised of a finite set of latent classes in unknown proportions. Each class/segment is characterized by a stochastic model defining the conditional density of the observations (*i.e.*, the population is made of a mixture of segments, with year-to-year contributions being governed by a segment-specific, finite-state Markov chain). As with other *post-hoc* segmentation models, the number of segments and segment characteristics is inferred based on alumni response/contribution data (Wedel and Kamakura 2000). This is in contrast to *a priori* segmentation models, as generally found in university fundraising models, where the number and types of segments are determined in advance by the researcher *e.g.*, study giving behavior in four segments: alumni, nonalumni, business and other donors, Leslie and Ramey (1988). To illustrate the use of the proposed approach, we analyze the contribution behavior of the alumni population of a Ph.D.-granting research university in the midwestern United States, from 2000 to 2009. The university wanted to identify more responsive donor segments within the existing alumni population that could be targeted *via* direct mail solicitations.

The remainder of the paper is organized as follows: in the next section we position our work with respect to the literature; we then present the general mixture modeling framework, along with an introduction to the expectation–maximization (EM) algorithm that is used to estimate the associated segmentation model parameters. An overview of the alumnus data used in our study is then presented. This is followed by a presentation of the notation and assumptions needed to formulate Markov chain mixture models. We then report on an extensive empirical study based on data from the university and discuss how the results are useful for direct marketing. Concluding remarks summarize the paper’s findings.

Table 1

Hypothetical sequences of contributions with identical RFM statistics — recency (R) = 1, frequency (F) = 5, average monetary value (M) = \$120.

Donor	Annual contribution amount				
	2008	2009	2010	2011	2012
A	\$120	\$120	\$120	\$120	\$120
B	\$200	\$160	\$140	\$80	\$20
C	\$50	\$75	\$130	\$160	\$185
D	\$80	\$140	\$60	\$180	\$140

Background and Literature Review

In this section, we position our work with respect to the non-profit (university) fundraising and market segmentation literature, and contrast our work to segmentation models developed as part of integrated frameworks to support optimization of direct marketing activities, paying special attention to dynamic segmentation models. Before discussing the literature, however, we first present an example to further motivate our approach.

Fundraisers at the university in our study relied, as is traditionally done in practice, on recency, frequency and monetary value (RFM) models and on demographic/trait information to segment the alumni population. Appeals, for example, may be sent to “alumni who graduated with a degree in architecture in the last five years, and donated at least \$100 in the last fiscal year.” This approach is grounded on the argument that the best predictor of future donor behavior is past behavior (Hughes 2000) and so donors with similar RFM characteristics and observed traits are grouped together.

To contrast this approach to the proposed framework, consider the four hypothetical alumni, their contribution sequences, as shown in Table 1. We note that each donor contributed in the last period (R = 1); each contributed in the last five years (F = 5); each has the same average contribution amount (M = \$120). Based on these data, the traditional segmentation approach, based on RFM statistics, suggests that all donors/alumni should be assigned to the same segment, and that as a result, should receive similar appeals.

While the summary statistics derived from the contribution sequences are identical, it is not clear that for direct marketing purposes, assigning these individuals to the same segment would be desirable. Specifically, the variability in donor D’s contribution sequence may indicate that she can be persuaded to donate in response to solicitations. Moreover, the variability, *i.e.*, trends, in the contribution sequences of donors B and C are ignored. That is to say, aggregation bias is introduced when RFM statistics are constructed in that although RFM statistics can be derived from contribution sequences, the contribution sequences *cannot* be reconstructed from RFM data. As a result, we propose to implement latent-class segmentation models¹ where donors are classified based on how an individual’s *contribution sequence* compares to those of other individuals. Our motivation is to model the dynamics that drive contribution

¹ In latent-class models, alumni are assumed to belong to a set of classes but whose individual class membership is unknown, and must be inferred.

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