

Applications of Optimization to Problems in Sales and Marketing

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Some of the earliest applications of optimization have been in marketing, starting with advertising media selection models in the 1970's. Below we give brief descriptions of some of these applications, as well as pointers on how to learn more.

1) **Advertising media selection:** If we are given: a) set of market segments we wish to reach, and b) a set of advertising media and some measure of how many people each medium reaches in each market segment, and c) an advertising budget,

then we want to decide how much to spend in each medium so that we maximize the value of the people that we reach, subject to not exceeding our advertising budget. In practice, a number of additional details are taken into account such as the decreasing returns to additional exposures in a given market. See the text "Optimization Modeling with LINGO" for an example.

2) **Sales territory design/realignment:** If we are given a list of (potential) customers, an estimate of how much work or time needs to be allocated to each customer per month, an estimate of the value of each customer, then allocate customers to sales representatives (reps) so that a) the work load is approximately equal among reps, b) the total value assigned to each rep is approximately equal, and c) the region assigned to each rep makes geographic sense, e.g., the customers are close together or contiguous. This approach has been used with some success in the pharmaceutical industry.

3) **Sales call planning:** This is the detailed, tactical, or daily version of the sales territory problem. If we are given a small set of customers who are good candidates for a given sales rep to visit today, then which ones should the rep visit and in what sequence so that the work fits into the time available for the day and we maximize the value of the customers visited minus the travel costs of visiting the customers.

4) **Revenue Management:** This methodology got its start in the airline industry and has expanded to a variety of other industries, particularly to products that "expire", such as seats on a particular flight, rooms in a hotel on a particular night, tickets to an event on a particular day, etc. In its simplest form RM takes into account the fact that there are some customers who will be willing to pay a very high price for your commodity just a few days or minutes before the flight departs or sports event. Unfortunately you have more tickets to sell than there are people who are willing to pay the high price, so some

of the tickets will have to be sold at a lower price. The optimization problem in its simplest form is deciding how many tickets to offer at the low price and how many tickets to hold back to hopefully sell at the higher price with the expectation that enough people will show up “just before show time” to buy the high priced tickets you have held back for them. See “Optimization Modeling with LINGO” for examples.

5) **Overbooking limits:** This may be considered as a special but older case of revenue management. Again, first used in the airline industry, it addresses the situation where you sell in advance a limited number of some commodity. If a nontrivial number of advance purchasers do not show up to claim their purchase, then you have the overbooking optimization problem of deciding how many units to sell beyond the actual number available, taking into account the opportunity cost of letting a unit go unused and the very real cost of dealing with a customer who shows up and finds unavailable the product that she expected. See “Optimization Modeling with LINGO” for detailed examples.

6) **Multi-product and Bundle Pricing:** When a firm is selling multiple products, the firm should take into account how some products are complements and some are substitutes. Bundle pricing is a form of quantity discounting. Under bundle pricing, a buyer can buy a combination of products, e.g., a word processing program and a spreadsheet program for less than the sum of prices of these products bought individually. If customers have diverse needs, e.g., some customers are willing to pay a lot for a word processing program and only a modest amount for a spreadsheet, whereas other customers are willing to pay a lot for a spreadsheet but only a modest amount for the word processor, then bundle processing may help. The optimization problem for the seller is to set prices for the individual products and for the various bundles so as to maximize total revenues, taking into account market segment sizes and that each market segment will buy that product or bundle that gives it the best deal in terms of value minus cost. See the text “Optimization Modeling with LINGO” for some detailed examples.

7) **Forecasting of new product acceptance:** When a new product is introduced there is a question of forecasting the sales each week. Bass introduced a popular model to predict the S shaped total acceptance curve that one typically sees for a new product. This model was originally used in predicting the acceptance of new styles of home appliances, as well as color televisions when they were first introduced. The basic idea is to describe the market by three numbers: M = the potential/final market size, p = the fraction of the market who are innovators and are likely to try a new product in any given period just because the product is available or heavily advertised, and q = a measure of the “word of mouth” effect or the fraction of the market who are imitators and will try the product only because someone else told them the product was good. A nonlinear optimization problem arises if one has preliminary sales data, or historical data on a similar product and one wishes to choose values for M , p , and q so as to minimize the retrospective

fitting error, and also hopefully produce a good forecast of sales next month. See the Bass Model in the Applications Library at <http://www.lindo.com>.

8) **Credit scoring and classification:** In sales, one may wish to classify potential customers into two or more classes, e.g., credit worthy or not, based on various attributes of the customer, e.g., educational level, salary, etc. Finding an appropriate “scoring formula” can be attacked in various ways, with Logit and Probit analysis being perhaps the most well known. As an optimization problem in its simplest form it is: given a set of historical data including attributes of customers and their actual classification, choose a weight for each attribute and a score threshold so that some measure of misclassification cost is minimized. See the models Logit.lng and Probit.lng in the Applications Library at <http://www.lindo.com>

9) **Conjoint analysis:** This methodology is concerned with how to position, and to some extent design, a product that has lots of attributes so that it comes close to matching the ideal product desired by the customer. A well known application of these ideas was to the design of the “Courtyard by Marriot” chain of business hotels. Potential customers have difficulty giving a complete specification of what is important to them in a product, so conjoint analysis asks one or more customers to make one of more simple comparisons between slightly different products, e.g., differing length of warranty, different price, different weight or size, etc. Given these ranking results, we want to choose a set of weights for the features so as to minimize the extent to which this weighting violates the rankings given by the customers. For examples, see the models conjoints.lng and conjointg.lng in the Applications Library at <http://www.lindo.com>

10) **Product mix problems:** This is the problem of deciding how much of which products to produce or sell in a product line. If different products use different amounts of different scarce production capacities, then maximize profit subject to these production constraints is a linear program. U.S. automobile manufacturers for example have an interest complication in this regard in that there are Federal limits on average fuel economy taken over all vehicles the manufacturer sells in the U.S. So for example, a manufacturer may wish to sell a number of moderately profitable high fuel economy cars because this will allow it to sell high profit, low fuel economy cars. See “Optimization Modeling with LINGO” for detailed examples.

11) **Shelf space allocation:** The manager of a retail store such as a supermarket must decide both where to place each stock keeping unit(SKU) on the shelf but also how much space or “facings” to allocate to the SKU. Products that are subject to impulse purchases should be placed in high traffic aisles and/or at eye level. SKU’s that appeal to children may be put on lower shelves. SKU’s that have high sales volume should receive more shelf facings because that will tend to reduce the labor devoted to keeping the SKU in stock. If you can quantify the value of giving each SKU a certain number of facings at

each possible shelf location, then you can maximize the value of the product shelf positioning, subject to not exceeding the available shelf space.

12) **Auctions:** There are certain situations when an auction is a good way of “clearing” a market. When one is selling multiple objects and there are various substitution and complementarity interactions among the objects being sold, then linear and integer programming are good methods for deciding who gets what and at what price. See for example the paper on multi-object auctions, as well as the model, `aucteq.ltx`, in the Applications Library at <http://www.lindo.com>.