Product Concept Evaluation Game Combining Preference Market and GA

Miku Imai, Hajime Mizuyama, Tomomi Nonaka
Aoyayama Gakuin University
mirai.331423@gmai.com, {mizuyama, nonaka}@ise.aoyama.ac.jp

Abstract

Preference market is a prediction market used for estimating preferences. This paper proposes a product concept evaluation system combining preference market and genetic algorithm (GA). It also provides a game-like framework to implement the proposed system.

Introduction

In today's rapidly changing marketplace, effective market research methods are required to identify consumers' needs and wants. Questionnaire survey is an often-used approach, and now a web-based one can aggregate responses easily from a large-scale sample. However, credibility of the responses remains an issue because the reward provided to respondents does not depend on the quality of their responses.

To resolve this problem, the authors have proposed a product concept evaluation system, which combines conjoint analysis with the knowledge aggregation function of preference markets (Dahan et al. 2011), as a means to compare the attractiveness of candidate new product concepts, and confirmed its efficacy by evolutionary game simulation (Imai and Mizuyama 2014). However, this system measures only the main effects of attributes but their interaction effects. If the system is used as is, too many securities (i.e., attribute sets) will be required to incorporate interaction effects.

This paper, therefor, extends the system by further combining genetic algorithm (GA). GA is a meta heuristic algorithm that imitates the process of organic evolution. In the extended system, individual product concepts are expressed as securities, and they are evolved depending on the evaluations of traders.

In addition, this paper discusses how to implement the proposed system to be actually used in the field. In order to do so, two problems should be resolved. Firstly, implementing the system as a "betting market" is difficult from a legal perspective. It is required to motivate traders with only play money incentives. Secondly, most consumers are not familiar enough with the security trading mechanism. An easy-to-understand and enjoyable mechanism framework is required to gain participation of many respondents. In order to resolve these problems, this paper focuses on the game with a purpose (GWAP) approach, and proposes a game-like framework to represent the preference market mechanism.

Proposed System

Product Concepts and Their Attractiveness

There are N candidate attributes, $B_1, B_2, ...B_N$, which can be incorporated into the new product under consideration and each attribute B_n has some levels, whose set is $L(B_n)$. Thus, each possible product concept can be denoted as $\boldsymbol{x} = (x_1, x_2, \ldots, x_N)^T$, where $x_n \in L(B_n)$ is the level of the attribute B_n.

The more attractive the product concept $\boldsymbol{x}$ is, the higher the market share the product will achieve if it is actually launched into the target market. In the proposed system, traders are expected to estimate the market share of some specified product concepts $\boldsymbol{x}_j (j = 1, 2, \ldots, J)$ and trade corresponding securities s_j.

To compare the relative market share among those product concepts, vote-share type securities are used whose values are proportional to the share of the corresponding product concepts. The system employs CMM (Central Market Maker) to ensure the liquidity of the securities and uses LMSR as the algorithm for CMM (Hanson 2003).

According to the logit market share model, the market share of ith product concept $\boldsymbol{x_i}$ can be expressed as:

$$S(\boldsymbol{x_i}) = A(\boldsymbol{x_i}) / \sum_{j=1}^{J} A(\boldsymbol{x_j}) \quad (1)$$

where $S(\boldsymbol{x})$ and $A(\boldsymbol{x})$ represent the expected market share and the attractiveness of the new product concept $\boldsymbol{x}$ respectively. Therefore, the purpose of the proposed system is to determine a product concept $\boldsymbol{x}$ whose $A(\boldsymbol{x})$ is the highest.

GA Approach to Determine Security Set

A simple approach to choose the most attractive product concept would be to estimate and compare $S(\boldsymbol{x})$ of all possible product concepts $\boldsymbol{x}$ by issuing the prediction securities corresponding to them all. However, this approach will require too many securities to be handled by human traders. Therefore, GA approach is taken to narrow down the set of product concepts compared in a preference market. According to the genotype setting, the prediction securities are en-

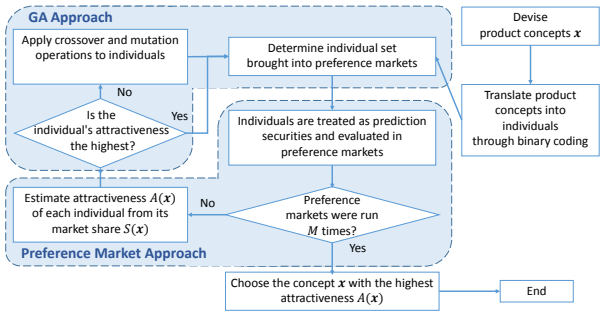

Figure 1: Overview of proposed system

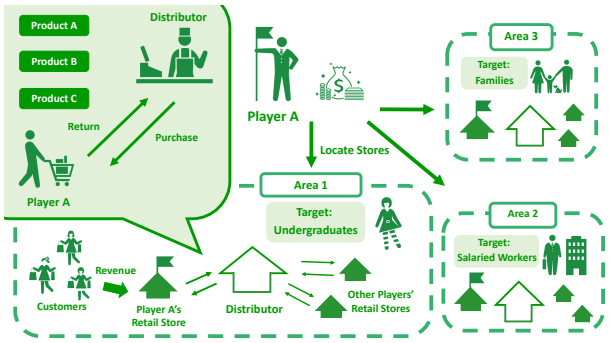

Figure 2: Overview of proposed game framework

coded through binary coding and they are evolved depending on the evaluations of traders, as shown in Figure 1.

Payoff Determination

Product concepts compared in the preference markets are in their hatching stage, and it is difficult to obtain their actual market share at the time of determining the payoff. Thus, the payoff should be determined somehow based on the status of the preference markets themselves. However, it is observed that this way may deteriorate the prediction accuracy.

Therefore, the following two devices are introduced for incentivizing traders to behave truthfully. Firstly, the system uses the smoothed values, such as VWAP (volume weighted average price), instead of the market closing price for estimating the attractiveness, and thereby reduces the impact of the transactions just before the closure. Secondly, it runs several preference markets in parallel and determines the payoff in each market by using the price data obtained from all of them, and thereby offsets the possible bias in the price data of a market.

Proposed Game Framework

This section discusses how to implement the proposed system as a predigested game which maintains the system's functions. The basic functions include (1) to induce players to estimate the market shares (i.e., attractiveness) of specified product concepts, (2) to let players trade goods (i.e., securities) corresponding to the concepts based on their estimated attractiveness, (3) to fluctuate the goods' prices according to the transactions, (4) to show players how the prices fluctuate,and (5) to calculate and provide a payoff for each good.

In the proposed game, each player manages one or more retail stores, as shown in Figure 2. There are some areas and target clientele differs from area to area. Each player can choose some areas to locate his/her retail stores, but only one store in one area. Then, the player buys some products from a distributor and sells them in a season, and the assets at the end of the season including the benefit are his/her game score.

The player can purchase products from several different distributors, and the category of products varies among distributors. Further, the assortment of products in a distributor changes between seasons. Any products should be bought in a lot unit, whose size differs from product to product so that the selling price of a whole lot is equal. Although the selling price of each product is decided in advance, its cost prices will vary according to its rating. The products can be returned to the distributer at any time within a purchase period, and the refund depends on its cost price at the time.

After a purchase period, the products arrive in the retail store. Then, the products may go out of stock or remain unsold in units depending on their attractiveness.

In this game, each distributor functions as a preference market, and the products purchased by the players from the distributer correspond to the prediction securities in the market. Their cost prices represent the security prices and are calculated based on LMSR. The product set sold in a distributor is determined by GA in every season.

As can be understood from that players purchase products in a lot unit, a product lot corresponds to a piece of prediction security. Further, the number of leftover products in each lot adjusts the difference between its selling price and the payoff of the corresponding prediction security.

Conclusion

This paper developed a product concept evaluation system by combining GA with the preference market mechanism, and implemented the system as a game. Experiments are also conducted with two web applications. One of them implements the proposed system according to the game framework, and the other implements the system as it is. In future work, the concept of idea market will be incorporated into the system to make it possible to collect new ideas from consumers.

References

Dahan, E., Kim, A.J., Lo, A.W., Poggio, T. and Chan, N. 2011. Securities Trading of Concepts (STOC). In *Journal of Marketing Research* 48:497-517.

Hanson, R. 2003. Combinatorial Information Market Design. In *Information Systems Frontiers* 5:107-119.

Imai, M. and Mizuyama, H. 2014. Product Concept Evaluation System Applying Preference Market. In *HCOMP 2014*.