Appendix 1. Summary of algorithm system to forecasting the demand in each product

1. Image of the algorithm system to forecasting the demand in each product

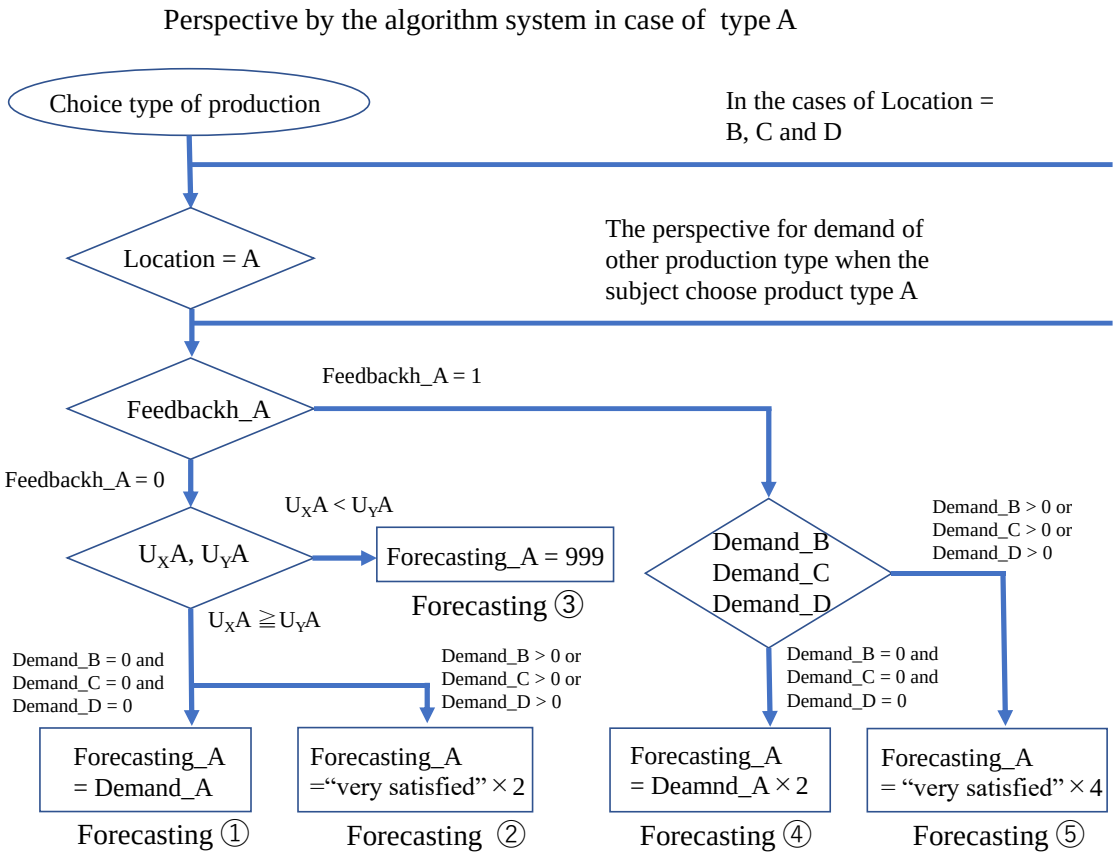

Figure 1A Image of the algorithm of forecasting system

2. Definition of variables in the figure 1

Product: Type the product that is chosen by Subject X.

Two subjects exist in the market. One of the subjects is defined as Subject X. Another subject is defined as Subject Y. In this summary, we suppose Subject X can use a forecasting system of the demand in each product. Definition of variables in figure 1 are as follows:

Feedbackh_A: Whether the subject can get half of the demand in product A.

(If Yes = 1, If No = 0)

U_XA: The utility gain of Product A's consumer from Subject X's product

U_YA: The utility gain of Product A's consumer from the Subject Y's product

Demand_A: Selling amount of products in product A

Demand_B: Selling amount of products in product B
Demand_C: Selling amount of products in product C
Demand_D: Selling amount of products in product D

3 Background for construction of forecasting system

・Subject X can understand what types of products were produced by Subject Y and how much price was offered by Subject Y after the end of the period (Subject Y can also get the information about Subject X's production type and price).

・Based on the information about the previous period, the forecasting system can clarify whether the attractiveness of subject X's product exceeds Subject Y's product in each type of product. In short, the system can clarify which product Subject X can sell its products. However, the system cannot clarify how many products sell in each product in many cases.

・If subject X only sells a specific type of product, the subject realizes how many demands exist for the product type in the market. In this case, the system can conclude the total demand for the product type. In short, the true total demand for the product becomes the same amount as the subject's selling amount.

・If the product's attractiveness between Subject X and Subject Y is the same in one type of product, the system realizes that Subject X can get half of the product's total demand. Therefore, in this case, the system can understand the true demand for the product (The true demand for the product becomes double the subject's selling amount.)

・Both subjects can get feedback on the selling products from the consumer. The consumers' feedback on the reputation of the subject's product was 50％, randomly. Reputation types depend on the distance of production type and price. Therefore, if the system cannot realize the true demand of each product by the selling amount, the system estimates the demand for each product using consumer feedback.

4. The example of forecasting

4.1 In the case of "Feedbackh_A = 0"

If the Subject X does not get half of the total demand in product A, "Feedbackh_A" becomes 0. In same time, if the consumers' utility gain from Subject X's product exceeds Subject Y's product（$U_XA > U_YA$）, the system supposes the following two possible forecasts;

Forecasting ①: In this case, the Subject X sell the product A to the consumers. On the other hand, Subject Y does not sell the product A to the consumers. If Subject X cannot get the demand from other products that exclude product A, the subjects ensure the demand in product A equals the sales amount in this period (Forecasting_A = Demand_A). In this case, the system can show product A's true number of demands.

Forecasting ②: If Subject X gets the demand from other products, Subject X cannot forecast the total demand of product A by the actual selling amount of products because the subject cannot identify how much sales in product A. The subject only understands the total sales amount, which is the summation of the sales in all product types. Instead of the information about the selling amount, the system can suspect the total demand of product A from consumer feedback. In this situation, the system supposes the number of "very satisfied" is equal to half of the total demand for product A. In short, the system supposes the number of feedback ("very satisfied") must become 50 percent of the total demand for product A every time. The forecast amount of the total demand in product A (Forecasting_A) becomes double the number of "very satisfied". In this forecasting, the system cannot show the true number of demands in product A. Because the actual number of feedback from consumer randomly slip out with half of the actual selling amount.

Forecasting ③: If the utility of X's product (product A) does not exceed Subject Y's product , Subject X's product cannot be sold. in this case, Subject 1 cannot get any information about the total demand in product A. Therefore, the forecast amount of the total demand is unknown (Forecasting_A = 999).

4.2 In the case of Feedbackh_A = 1

If subject X gets half the total demand in product A, Feedbackh_A becomes 1.

We can suppose the following two possible forecasts based on the actual selling amount and consumer feedback.

Forecasting ④: If Subject X gets the demand from other products, the subjects ensure the demand in product A equals double the sales amount in this period (Forecasting_A = Demand_A×2). In this case, the system can show product A's true number of demands.

Forecasting ⑤: If Subject X gets the demand from other products(product B, C, and D), subject X cannot forecast the total demand of product A by the actual selling amount of products. Instead of the information about the selling amount, the system can suspect the total demand from consumer feedback. In this situation, the system supposes the number of "very satisfied" equals a quarter of total demand in product A. The forecast amount of the total demand in product A (Forecasting_A) becomes quadruple the number of "very satisfied". In this forecasting, the system cannot show the true number of demands in product A. Because the actual number of feedback from consumer randomly slip out with half of the actual selling amount.

5. Update the forecasting demand of each product's type

After this period, the subjects using the forecasting system confirm the forecasting amount of the total demand in each product. The estimated demand for each product will update as the period passes. Update rule relies on the following formulation.

$$Forecasting_{s,j,t} = \frac{Forecasting_{s,j,t-1} + Forecasting_{s,j,t-2}}{2}$$

This formulation, *s* shows each subject that can use the forecasting system. *j* shows the product's type. *t* shows the period in the experiment. When period *t* starts, the subjects can confirm the forecasting demand of each product's type. This forecasting demand of each product's type in t is calculated by the average value between the estimated forecasting demand in *t*-1 and *t*-2.

In some cases, the system defines the true total demand of each product type. For example, in the case of Forecasting ① and Forecasting ④ in Figure 1A, the system can logically define the true demand for product A because the subject can get all or half of the total demand for product A. In these cases, the system will fix the estimated demand for product A and stop the update of the estimated demand from the next period.