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New statistical analysis in marketing research with fuzzy data☆

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ABSTRACT

This research proposes new statistical methods for marketing research and decision making. The study employs a soft computing technique and a new statistical tool to evaluate people's thinking. Because the classical measurement system has difficulties in dealing with the non-real valued information, the study aims to find an appropriate measurement system to overcome this problem. The main idea is to decompose the data into a two-dimensional type, centroid and its length (area). The two-dimensional questionnaires this study proposes help reaching market information.

1. Introduction

Talking about promoting the quality of market research is not possible without tackling the problem of implementing an efficiency evaluation tool, to systematically gauge work performance. The application of this measurable system requires setting up a metric system for sampling survey or field studies with fuzzy data.

Given the nature of the topic, studies of market research and decision management could have analyzed how people plan and execute their activities within a given time interval; researchers could have investigated plan-action discrepancies as a function of dynamic events, time budgets, etc. However, most research studies use cross-sectional designs and measurement instruments that emphasize stability rather than dynamic aspects of time-management behavior. Future research could profit much from dynamic approaches to theory building and research (Nguyen & Wu, 2006a, 2006b; Nguyen, Kreinovich, Wu, & Gang, 2011).

In many fields, such as human language, thought, and decision making—where categorization (or ranking) is vague and non-quantitative, often simply non-specific preferences—significant data may get lost easily. Consequently, statistical phenomena can easily and quickly describe the basic structure of the information for data analysis, employed in many academic areas.

Many researches focus on the applications of fuzzy statistical analysis in the social sciences, who identify the model construction through qualitative simulation. Wu and Tseng (2002) use a fuzzy regression method of coefficient estimation to analyze Taiwan monitoring index of economics. Nguyen et al., (2011) provide an extensive treatment of the theory of fuzzy statistics.

2. Literature review

Marketing research involves the process of determining needs, setting goals to achieve these needs, prioritizing and planning tasks required to achieve these goals, although several other definitions exist. Macan (1996) proposes a technique for effective time use, specifically, having enough time to accomplish the many tasks required, planning and allocating time. Strongman and Burt (2000) intend to maximize intellectual productivity, to assess the relative importance of activities through the development of a prioritization plan. In their book, Kahraman and Yavuz (2010) represent all areas of production management that reflect the natural order of production management tasks. The authors focus on applicability and wherever possible, numerical examples appear.

Marketing management behaviors comprise (1) marketing assessment behaviors, which aim at the awareness of here and now or past, present, and future and self-awareness of marketing use (attitudes and cognitions, which help to accept tasks and responsibilities that fit within the limit of marketing capabilities); (2) planning marketing behaviors, such as setting goals, planning tasks, prioritizing, making to-do lists, and grouping tasks (Lee, Chang, & Wu, 2012; Macan, 1996), which aim at an effective use of marketing; and (3) monitoring behaviors, which aim at observing people's use of marketing while

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performing activities, generating a feedback loop that allows limiting the influence of others' interruptions (Wu, Mei, & Zhong, 2012).

Building on the above discussion, this study proposes an idea of marketing management as “behaviors that aim at achieving an effective use of time while performing certain goal-directed activities.” This definition emphasizes that the efficient evaluation of marketing management depends mainly on the difference between expectation and market observation (realization).

Marketing management questionnaires include factor items on (1) attitudes' tendency towards marketing management (e.g., “do you feel you are in charge of your own market, by and large?”), and on (2) planning the allocation of market. The scale consists of three factors, namely short-range planning, long-range planning, and time attitudes.

Setting organizations' goals and priorities relates positively to perceived control, whereas mechanics of time management relate negatively to perceived control of time. Claessens, van Eerde, Rutte, and Roe (2004) use a different marketing management scale to test the mediation model over time. Instead, this research uses a planning scale. This study also reveals partial mediation of control of time. In conclusion, these studies find some support for a process model that hypothesizes perceived control of time to fully mediate between time management behaviors and job- and person-related outcomes.

Many studies relate marketing management activity to several other outcome variables. Some studies look into the effects on proximal variables, such as accurately estimated time duration, and spent time on high-priority tasks. Other studies examine the effects on performance in work and academic settings, such as job performance, academic performance, and total study habits score. As for emotional exhaustion, Peeters and Rutte (2005) find that time management moderates the relation between high demands and low autonomy on the one hand, and emotional exhaustion on the other hand.

3. Statistical analysis with soft computing

3.1. Questionnaire with fuzzy set theory

Regarding the choice of statistical tools in the evaluation, and because the evaluation must align with the same logic base, significant differences should exist on the metrics. Finding the well-established evaluation system that goes along with this study goals and objectives is the key.

After the study of fuzzy graphic rating scale (FGRS) by Hesketh, Pryor, Gleitzman, and Hesketh (1988); Costas, Maranon, and Cabrera (1994) chose 100 university students as a sample of the research. They found that FGRS fits in the feature of human psychology. Herrera and Herrera-Viedma (2000) present the steps of linguistic decision analysis under linguistic information. Building on fuzzy number, their statements show different degrees of possibilities to express linguistics; however, studies must consider whether the response will produce the same fuzzy number. Building on the similarity of the linguistic concept, they present a formula of fuzzy association degree. Carlsson and Fuller (2000a); Carlsson and Fuller (2000b); Chiang, Chow, and Wang (2000), and Herrera and Herrera-Viedma (2000) discussed many concepts regarding the computation of fuzzy linguistic worthy broadcasting.

Drawing from previous statements: (1) the methods of traditional statistical analysis and measurement used in public consensus are incomplete. Building on the fuzzy feature of human thought, research should deeply consider and discuss quantifying the measurement of public consensus using the fuzzy number. (2) The measurement of attitudes and feelings building on the fuzzy set theory is a very common method in recent years. Many associated scholar areas in this type of research exist. Meanwhile, educational and psychological researches are still not as many. In conclusion, the theory research of fuzzy mode and experimental discussion this study presents is a possible solution of importance.

In the research of social sciences, the sampling survey always evaluates and understands public opinion on certain issues. The traditional survey forces people to choose fixed answers from the survey, but the survey ignores the uncertainty of human thinking. For instance, when people need to answer a survey that lists five choices such as “Very satisfactory,” “Satisfactory,” “Normal,” “Unsatisfactory,” “Very unsatisfactory,” despite that the answer is continual, respondents must choose an answer. This election limits the flexibility of the answer. When the survey proposes to have the answer for sleeping hours of a person, describing the feeling or reasonably understanding such feeling is difficult unless the study uses fuzzy statistics.

Traditional statistics deal with a single answer or with a certain range of the answer through sample survey, and are unable to sufficiently reflect the thought of an individual. If people use the membership function to express the degree of their feelings building on their own choices, the answer will be closer to real human thinking. Therefore, collecting the information based on the fuzzy mode is more reasonable.

3.2. The nature of fuzzy answering

Because many replies from sampling survey seem vague, uncertain, and incomplete, the information itself is divisible into continuous and discrete. This section includes brief definitions with fuzzy data.

Continuous fuzzy data are classifiable into several types, such as interval, triangular, trapezoid numbers, and exponential. The logic of the following interval analysis is one of certain containment. For example, the sum of two intervals certainly contains the sums of all pairs of real numbers, one from each of the intervals. This logic follows the definitions of interval arithmetic, drawing from simple properties of the order relation ≤.

The definition for the trapezoid data is basically the generalized form for the interval and triangle form.

A fuzzy number $A=[a,b,c,d]$, defined on the universe set U of real number R with its vertex $a \le b \le c \le d$, is presumably a trapezoidal fuzzy number if its membership function is given by $u_F(x) = \frac{x-a}{b-a}$ if $a \le x \le b$; $u_F(x)=1$, if $b \le x \le c$, $u_F(x) = \frac{d-x}{d-c}$ if $c \le x \le d$ and equals to 0. Otherwise, if $b \le x \le c$; when $b=c$, A is a triangular data; when $a=b$, $c=d$, A is an interval-valued data.

Respondents choose one single answer or a certain range of the answer in the traditional sampling survey. However, the traditional method is not able to truly reflect the complex thoughts of each respondent. If people can express the degree of their feelings by using membership functions, the answer will be closer to real human thoughts. Nevertheless, scholars unfortunately disagree about the construction of continuous fuzzy data. Many studies use continuous fuzzy without describing the construction method. The core of all the questions is fuzzy data that its membership function determines, but the construction of membership function is quite subjective. To reflect this, the respondents must determine the membership function building on GSP software.

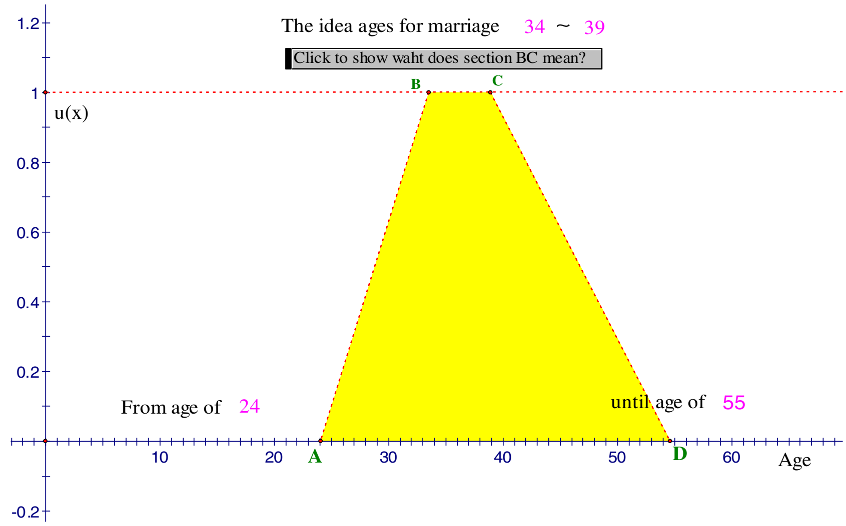

Fig. 1. A fuzzy answering for the expected marriage age.

Fig. 1 is the image of a fuzzy questionnaire that is about the prime time for marriage. Before answering the fuzzy questionnaire, respondents could click the three buttons to acknowledge the meaning of each section and point. For example, people may decide $\overline{AB}$ that represents the desire for marriage that grows continuously from 24 years to 34. $\overline{BC}$ represents that the desire for optimal marriage is from 34 to 39 years old. $\overline{CD}$ represents the desire for marriage from 39 until 55.

Respondents can decide their own membership function of the prime time for marriage by moving the four points A, B, C, and D. By moving the four points, the age corresponding to the points will change automatically.

3.3. Measurement with fuzzy data

A trapezoid fuzzy set resembles a continuous fuzzy set, which further represents uncertain events. In a sample of trapezoid data, the researcher's interest lays in scaling its value on the real line. In some practical applications, however, considering that instead of the original class of all linear re-scalings a more general class of non-linear transformations between scales exists is reasonable. For example, the energy of an earthquake is described both in the usual energy units and in the logarithmic (Richter) scale. Similarly, the power of a signal and/or of a sound is measured in watts and also in the logarithmic scale.

When considering the reasonable and meaningful conditions to map trapezoid-data into the real line, identifying two conditions is necessary. Thus, the transformation data should be: (1) finite-dimensional, and (2) the dependence on these parameters should be smooth (differentiable). In mathematical terms, this means that this transformation group is a Lie Group.

After selecting the transformation, instead of the original trapezoid-data, a new value y = f(x) appears. In the ideal situation, this new quantity y is normally distributed. (In practice, a normal distribution for y may be a good first approximation). When selecting the transformation, because of the possibility of a rescaling, taking into account that the numerical values of the quantity x is not uniquely determined is necessary.

Definition 3.1. Scaling for a trapezoid fuzzy number on R:

Let $A=[a,b,c,d]$ be a trapezoid fuzzy number on U with its centroid $(cx,cy)=\left(\frac{\int x u_A(x)dx}{\int u_A(x)dx},\ \frac{\int \frac{1}{2}(u_A(x))^2 dx}{\int u_A(x)dx}\right)$. Then the defuzzification value RA of $A=[a,b,c,d]$ is $RA=cx+\frac{\|A\|}{2\ln(e+\|cx\|)}$; where $\|A\|$ is the area of the trapezoid.

Note that for convenience this should appear $\|A\|=\frac{a+b+c+d}{4}$, if A is a trapezoid; $\|A\|=\frac{a+b+c}{3}$, if A is a triangle; $\|A\|=\frac{b+c}{2}$, and if A is an interval.

Example 3.1. Let $A_1=[2,2,3,3]$, $A_2=[1,1,4,4]$, $A_3=[1,2.5,2.5,4]$, $A_4=[1,2.5,2.5,8]$, $A_5=[1,2,3,4]$, $A_6=[1,2,3,8]$ be the fuzzy data. According to Definition, Table 1 illustrates the defuzzification values.

However, some of the literature and definitions appear in the measurement system. In this section, the study proposes a well-defined distance for trapezoid data.

Definition 3.2. Let $A_i=[a_i,b_i,c_i,d_i]$ be a sequence of trapezoid fuzzy number on U with its centroid $(cx,cy)=\left(\frac{\int x u_A(x)dx}{\int u_A(x)dx},\ \frac{\int \frac{1}{2}(u_A(x))^2 dx}{\int u_A(x)dx}\right)$. Then the distance between the trapezoid fuzzy number A_i and A_j is:

$$d(A_i,A_j)=|cx_i-cx_j|+\left|\frac{\|A_i\|}{2\ln(e+\|cx_i\|)}-\frac{\|A_j\|}{2\ln(e+\|cx_j\|)}\right|.$$

Example 3.2. Let the fuzzy data be $A_1=[2,2,3,3]$, $A_2=[1,1,4,4]$, $A_3=[1,2.5,2.5,4]$, $A_4=[1,2.5,2.5,8]$, $A_5=[1,2,3,4]$, $A_6=[1,2,3,8]$. According to Definition 3.2 Table 2 illustrates their distance.

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Table 1
Defuzzification for fuzzy data.

Fuzzy data	cx	$\frac{\|A\|}{2\ln(e+\|cx\|)}$	RA
$A_1=[2,2,3,3]$	20.5	0.30	2.80
$A_2=[1,1,4,4]$	20.5	0.91	3.41
$A_3=[1,2.5,2.5,4]$	20.5	0.45	2.95
$A_4=[1,2.5,2.5,8]$	30.5	0.96	4.46
$A_5=[1,2,3,4]$	20.5	0.61	3.16

The distance states the gap between observed data and expected value; the smaller distance demonstrates that observed data fits the expected values.

To have a clear picture of the distance between idea and actual data, the following definition about efficiency is necessary, because the value will be a standardized constraint between 0 and 1. The study uses exponential transformation f(x), which transforms the distance of fuzzy data set of possible values of x into (0,1). A natural symmetry requirement indeed explains the selection of exponential function as an appropriate transformations of all-positive quantities.

3.4. Two-dimensional questionnaires and answering

In this research, the subject has to answer two-dimensional questionnaires (X, Y). The two-dimensional questionnaire requires that the subject answers not only to the relative weight X for the factor but also the membership (degree of the feeling) for the factor Y.

For instance, let U be the discussion domain with k linguistic factors $(x_1, x_2, \ldots, x_k)$. $(y_1, y_2, \ldots, y_k)$ stands for the membership (degree of the feeling) for corresponding factor x_i ; whereas $\sum_{i=1}^{k}\mu_i(x) = 1$ and $\mu_i(y) \rightarrow (0,1)$. Hence, the two-dimensional sample appears as:

$$\mu_U(X,Y) = \frac{(\mu_1(x);\mu_1(y))}{x_1} + \frac{(\mu_2(x);\mu_2(y))}{x_2} + \ldots + \frac{(\mu_k(x);\mu_k(y))}{x_k}$$

where "+" means "or" instead of the traditional meaning "addition".

For the real computation, suppose $(x, y_j) = \frac{(\mu_1(x);\mu_1(y_j))}{x_1} + \frac{(\mu_2(x);\mu_2(y_j))}{x_2} + \ldots + \frac{(\mu_k(x);\mu_k(y_j))}{x_k}$, $j = 1,2,\ldots,n$, be a series of random sample. Then the fuzzy mean F_s for this data will be:

$$F_s = \frac{\left(\frac{1}{n}\sum_{j=1}^{n} x_{1j}, \frac{1}{n}\sum_{j=1}^{n} y_{1j}\right)}{x_1} + \frac{\left(\frac{1}{n}\sum_{j=1}^{n} x_{2j}, \frac{1}{n}\sum_{j=1}^{n} y_{2j}\right)}{x_2} + \ldots\ldots + \frac{\left(\frac{1}{n}\sum_{j=1}^{n} x_{kj}, \frac{1}{n}\sum_{j=1}^{n} y_{kj}\right)}{x_k}$$

whereas (x_i, y_i) is the recorded data for weight of factors and the feeling for peoples thinking.

If the fuzzy data is recorded as a discrete type, these data transform into a real value between 0 and 1. That is, $S_i = \frac{1}{m-1}\left[\sum_{j=1}^{m} j\cdot\mu_j(y_i) + \frac{1}{m-1}\left(\sum_{j=1}^{m}\mu_j(y_i)\cdot\left|j - \sum_{j=1}^{m} j\cdot\mu_j(y_i)\right|\right)\right]$, where $\mu_j(x_i)$ is the weight of the factor j. To find the general index of satisfactory, a calculation of the mean of the sample IS through population is necessary. That is, the general index:

$$GIS = \frac{1}{n}\sum_{i=1}^{n} IS_i.$$

To make the expression easier to understand, the sample transforms in a matrix form.

Definition 3.3. Fuzzy sample with matrix form:

Let U and V be two discussion domain, $\{L_i, i = 1,2,\ldots,n\}$ be a sequence of linguistic (ordered) variables on U, $\{P_j, j = 1,2,\cdots,m\}$ be a sequence of linguistic variables on V. Let $\{S_k, k = 1,2,\ldots,r\}$ be a sequence of fuzzy sample. For each sample, S_k, has membership function $u_{i,k}$ corresponding to linguistic variables $L_i(\sum_{i=1}^{n} u_{i,k} = 1$, and has membership function $v_{ij,k}$ corresponding to linguistic variables $P_i(\sum_{j=1}^{m} v_{ij,k} = 1)$.

Table 2
Distance for big data.

$d(A_i,A_j)$	$A_1=[2,2,3,3]$	$A_2=[1,1,4,4]$	$A_3=[1,2.5,2.5,4]$	$A_4=[1,2.5,2.5,8]$	$A_5=[1,2,3,4]$
$A_1=[2,2,3,3]$	0	0.61	0.15	1.66	0.31
$A_2=[1,1,4,4]$		0	0.46	1.05	0.30
$A_3=[1,2.5,2.5,4]$			0	1.51	0.16
$A_4=[1,2.5,2.5,8]$				0	1.35
$A_5=[1,2,3,4]$					0

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Table 3
Data from three customers.

	7-eleven			Family			Hi-life		
	Sanitation	Service	Variety	Sanitation	Service	Variety	Sanitation	Service	Variety
A	0.3			0.5			0.2		
	0.4	0.4	0.2	0.1	0.4	0.5	0	0.6	0.4
B	0.5			0.4			0.1		
	0.1	0.4	0.5	0.1	0.3	0.6	0.1	0.5	0.4
C	0.2			0.6			0.2		
	0.3	0.3	0.4	0.3	0.2	0.5	0.4	0.3	0.3

The above sample matrix goes as follows:

$$S_k \begin{bmatrix} (v_{11}, u_1)_k & (v_{21}, u_2)_k & \cdots & (v_{n1}, u_n)_k \\ (v_{12}, u_1)_k & (v_{22}, u_2)_k & \cdots & (v_{n2}, u_n)_k \\ \vdots & \vdots & \ddots & \vdots \\ (v_{1m}, u_1)_k & (v_{2m}, u_2)_k & \cdots & (v_{nm}, u_n)_k \end{bmatrix}.$$

Definition 3.4. Fuzzy sample mean with matrix form

Let $\overline{\mathrm{u}}_{\mathrm{i}} = \frac{1}{\mathrm{r}} \sum_{\mathrm{k}=1}^{\mathrm{r}} \mathrm{u}_{\mathrm{i,k}}$, $\overline{\mathrm{v}}_{\mathrm{ij}} = \frac{1}{\mathrm{r}} \sum_{k=1}^{\mathrm{r}} v_{ij,k} u$, for a sequence of fuzzy sample with matrix form

$$S_k = \begin{bmatrix} (v_{11}, u_1)_k & (v_{21}, u_2)_k & \cdots & (v_{n1}, u_n)_k \\ (v_{12}, u_1)_k & (v_{22}, u_2)_k & \cdots & (v_{n2}, u_n)_k \\ \vdots & \vdots & \ddots & \vdots \\ (v_{1m}, u_1)_k & (v_{2m}, u_2)_k & \cdots & (v_{nm}, u_n)_k \end{bmatrix}.$$

Then the fuzzy sample mean with matrix form can be demonstrated as:

$$\overline{S} = \begin{bmatrix} (\overline{v}_{11}, \overline{u}_1) & (\overline{v}_{21}, \overline{u}_2) & \cdots & (\overline{v}_{n1}, \overline{u}_n) \\ (\overline{v}_{12}, \overline{u}_1) & (\overline{v}_{22}, \overline{u}_2) & \cdots & (\overline{v}_{n2}, \overline{u}_n) \\ \vdots & \vdots & \ddots & \vdots \\ (\overline{v}_{1m}, \overline{u}_1) & (\overline{v}_{2m}, \overline{u}_2) & \cdots & (\overline{v}_{nm}, \overline{u}_n) \end{bmatrix}$$

where $\overline{u}_i = \frac{1}{r} \sum_{k=1}^{r} u_{i,k}$, $\overline{v}_{ij} = \frac{1}{r} \sum_{k=1}^{r} v_{ij,k}$.

Example 3.3. Customer preferences about three leading super markets. Table 3 shows three samples. (See Table 4.)

Then the fuzzy sample matrix for

$$\mathrm{A} = \begin{bmatrix} (0.4, 0.3) & (0.1, 0.5) & (0.0, 0.2) \\ (0.4, 0.3) & (0.4, 0.5) & (0.6, 0.2) \\ (0.2, 0.3) & (0.5, 0.5) & (0.4, 0.2) \end{bmatrix}$$

$$\mathrm{B} = \begin{bmatrix} (0.1, 0.5) & (0.1, 0.4) & (0.1, 0.1) \\ (0.4, 0.5) & (0.3, 0.4) & (0.5, 0.1) \\ (0.5, 0.5) & (0.6, 0.4) & (0.4, 0.1) \end{bmatrix} \quad \mathrm{C} = \begin{bmatrix} (0.3, 0.2) & (0.3, 0.6) & (0.4, 0.2) \\ (0.3, 0.2) & (0.2, 0.6) & (0.3, 0.2) \\ (0.4, 0.2) & (0.5, 0.6) & (0.3, 0.2) \end{bmatrix}.$$

Table 4
Fuzzy correlation for four brands.

	Sony	Apple	hTC	Samsung
Price	0.067	0.727	0.373	0.481
Function	0.038	0.247	0.080	0.168
Appearance	−0.127	0.323	0.350	−0.127
Brand	0.032	0.402	0.102	−0.438

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And its fuzzy sample mean is:

$$\bar{S} = \begin{bmatrix} \left(\frac{0.4+0.1+0.3}{3},\frac{0.3+0.5+0.2}{3}\right) & \left(\frac{0.1+0.1+0.3}{3},\frac{0.5+0.4+0.6}{3}\right) & \left(\frac{0.0+0.1+0.4}{3},\frac{0.2+0.1+0.2}{3}\right) \\ \left(\frac{0.4+0.4+0.3}{3},\frac{0.3+0.5+0.2}{3}\right) & \left(\frac{0.4+0.3+0.2}{3},\frac{0.5+0.4+0.6}{3}\right) & \left(\frac{0.6+0.5+0.3}{3},\frac{0.2+0.1+0.2}{3}\right) \\ \left(\frac{0.2+0.5+0.4}{3},\frac{0.3+0.5+0.2}{3}\right) & \left(\frac{0.5+0.6+0.5}{3},\frac{0.5+0.4+0.6}{3}\right) & \left(\frac{0.4+0.4+0.3}{3},\frac{0.2+0.1+0.2}{3}\right) \end{bmatrix}$$
$$= \begin{bmatrix} (0.27,0.33) & (0.17,0.50) & (0.17,0.17) \\ (0.37,0.33) & (0.30,0.50) & (0.47,0.17) \\ (0.37,0.33) & (0.53,0.50) & (0.37,0.17) \end{bmatrix}.$$

4. An empirical study

Customers' satisfaction with cell phones is an important information for the future cell phone marketing research. This study uses interval-valued fuzzy data and two dimensional questionnaires to evaluate the satisfaction and proposes a model to conduct an empirical research regarding the satisfaction with the cell phone. 210 undergraduate students participate—100 males, 120 females—at National Chengchi University, Taiwan. The investigation takes place during May 2015.

The four leading cell phone brands in the Taiwan market are Sony, Apple, HTC, and Samsung. This study investigates the degree of satisfaction attending to four factors: price, function, appearance, and brand.

Firstly, the sample mean matrix is

$$\bar{S} = \begin{bmatrix} (0.328,0.175) & (0.276,0.539) & (0.319,0.170) & (0.291,0.116) \\ (0.239,0.175) & (0.312,0.539) & (0.279,0.170) & (0.243,0.116) \\ (0.298,0.175) & (0.217,0.539) & (0.267,0.170) & (0.226,0.116) \\ (0.135,0.175) & (0.194,0.539) & (0.135,0.170) & (0.240,0.116) \end{bmatrix}.$$

For instance, 0.175, 0.539, 0.170, 0.116 are the mean for the four brands: Sony, Apple, hTC, Samsung. Whereas 0.319, 0.279, 0.267, 0.135 are membership function for the four factors conditional in hTC choice. The fuzzy mode for brand of the cell phone is $\max\left\{\frac{38.5}{\text{Sony}},\frac{118.5}{\text{Apple}},\frac{37.4}{\text{hTC}},\frac{25.6}{\text{Samsung}}\right\} = \frac{118.5}{\text{Apple}}$.

This result means that most students like the Apple cell phone. Whereas the fuzzy mode for the factors is:

$$\max\left\{\frac{60.699}{\text{price}},\frac{68.041}{\text{function}},\frac{50.413}{\text{apperence}},\frac{40.848}{\text{brand}}\right\} = \frac{68.041}{\text{function}}.$$

Hence, students are likely to choose function as a priority.

4.1. Characteristics

1. From the brand point of view: Apple vs price has large negative correlation, whereas the rest have a positive correlation.
2. From the function point of view, Apple has a higher positive correlation compared to other brands. This result shows that, in the students market, Apple is a priority ahead of other brands.

5. Conclusions

Soft computing techniques are growing as a new discipline responding to the necessity to deal with vague samples and imprecise information that human thought causes in certain experimental environments. In this context, available observed data are coarse in a specific sense. The necessity to conduct research for this case is two-fold: (1) Providing multivariate model building and dependence analysis for fuzzy data observations, and (2) providing the legitimate framework for an important (engineering) domain of applications, generalizing Bayesian statistics, namely, the theory of belief functions (for fusion or combination of evidence).

The proposed techniques can render a more sophisticated and detailed interpretation of the data than the conventional ones, especially when the data could not show a clear cut human thought. In addition, the data triggers the question for constructing continuous fuzzy data which truthfully explains the flow of human ideology.

The crucial question is: what is the optimal, best fitted model for a set of fuzzy data? Is the SSE or the AIC still available to choose the best fitted model? Obviously, open research is on a comprehensive theory of finite random samples, comparable with that of random vectors, including elements such as "covariance of random samples" and "expected random sets". This theory can apply to the case of big data random samples.

The study carefully reveals how to use fuzzy statistics in people's time management effectiveness of fuzzy time allocation and management assessments. Empirical studies demonstrate how to measure fuzzy data that can deal with trapezoid, triangular, and interval-valued data simultaneously and how to perform the nonparametric hypothesis testing.

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