

## Modeling the Selection of a Product Through its Attributes by Using Probabilistic Neural Networks and Discriminant Analysis

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**Abstract:** The aim of this paper is Modeling the selection of a product through the attributes of the product. In fact we want to recognize the most important attributes of a product that influence product choice. We use probabilistic neural networks tool and discriminant analysis tool for this modeling to compare these tools. This paper chooses the mobile phone as the research product. We use questionnaires to collect data in Qom city. Result of this research explores influential attributes of mobile phone on the selection of the brand and influential attributes of mobile phone on the selection of the price in two way and the level of important of these attributes. In addition, this paper show neural networks tool is more power than discriminant analysis tool in this modeling and neural networks need less variables than discriminant analysis for modeling.

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**Key words:** Attributes of product • Mobile phone • Discriminant analysis • Probabilistic neural networks

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### INTRODUCTION

At present mobile phone network covers 80% of population all over the world and it's predicted that up to 2010, it will over cover 90% of 60 billion population. This increasing process shows a revolution in using this communicative tool. A revolution that has never seen in the history of any consumer goods. Iran is not an exception and during the last 15 years, the number of mobile phone users has increased from 10,000 to 20 million users.

Along with technology advancement and innovation, varieties of modern phones and new different capabilities, has made a severe competition in the mobile phone market. Without identifying the influential attributes of products, it's impossible to last to a long time and acquire the competetional advantage in this market. In fact, taste of the target market, which differs in various parameters, should be identified and the goods or the proper services are offered to that market. Home produced mobile phone that were not popular, smuggling 80% mobile phone in the country, show lack of planning and lack of study of internal market to satisfy it's needs. Identifying the influential attributes of products in selecting a mobile phone can play an efficient role in the official, planning for producing, import and export of mobile phone.

Because of large number of varieties and the presence of many relations and complexities in traditional

modeling, modeling the relation between influential attributes of products and the kind of the products is not efficient. So the neural networks with capabilities of acquiring the relationship between variables- no matter how complex they are- can be used. In this research, the influential attributes of this product has been identified and it has been tried to model this relationship using the neural networks. As the discriminant analysis method is used in modeling the relationship between variables, this technique is also used in this paper to explore it's power in comparison with neural networks method. At first, we will have a brief literature review on attributes of product, discriminant analysis and neural networks and then subject of the research i.e. Modeling the selection of a product through the attributes of the product will be discussed and finally the result of the modeling will be explored and necessary suggestions will be offered.

**Attributes of Product:** The satisfy of utility on consumer not only depends on purchasing product but also from product characteristics [1]. Ladd and Suvannunt [2] also express that product characteristics affects the demand function of goods on consumer in the consumer goods characteristics model (CGCM). In fact consumers evaluate the value of a product or service by combining the separate amounts of value provided by each attribute and attributes of product are important as a competitive tools.

In this paper attributes of mobile phone are divided in four groups: performance attributes, entertainment attributes, technological attributes and appearance attributes. These four groups of attributes are in Hedonic aspect and applied aspect of product. Mobile phone has applied aspect (such as communication, time planning and ...) and Hedonic aspect (such as games, camera and ...) [3].

In this research we use 30 attributes of mobile phone as initial attributes to discover level important of them from consumer's aspect.

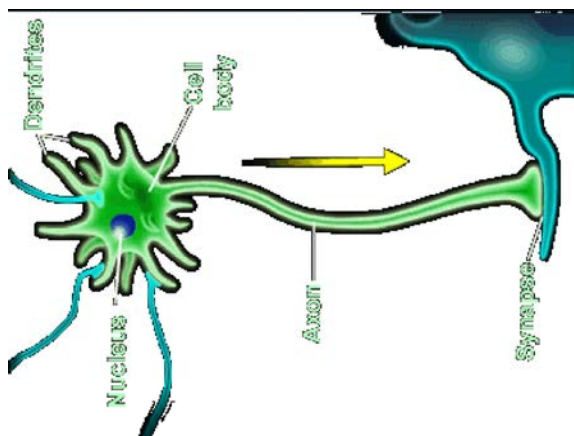
**Discriminant Analysis:** Discriminant analysis is a statistical method that uses present data for groups of variables for the purpose of classification. This method builds a discriminant equation for group variables in independent groups. The most frequent type of discriminant equation is the liner one, which was developed by Sir Ronald A.Fsher in 1930s with name of Linear Discriminant Analysis. in this paper we use attributes of mobile phone as input variables and brand variable and price variable as output variables in distinct models and we use SPSS software for analysis.

**Neural Networks:** The aim of artificial networks is to build a structure like biological structure of human's mind and neural network of the body in order for it to have the power of learning; artificial neural networks don't need mathematical model. This networks show experiences like humans and then generalize these experiences. Today these networks are used for solving many problems such as model recognition, classification and anticipation and they have applications in many scientific branches.

**Neural Network's Construction:** Basic concept of neural networks is the systematic construction of data processing, which consists of many processing units (neuron), connected to networks. Biological neural cell or neuron is the constituent of neural system in humans.

#### Every Neuron Consists of the Following Main Parts:

- Cell body contains the core and other cellular parts originate from it.
- Axon is responsible for transmitting information from neural cell.
- Dendrite is responsible for transmitting information from other cells to the neural cell.



#### Types of Neural Networks According to Application:

Up to now, different topologies along with various applications are offered to neural networks, that covers a wide range of issues. Different types of neural networks according to their applications are divided in to 3 general classes: 1-improvemental like self organizing 2-classifier (organizer) like Darwin networks and probabilistic networks 3-predictive like Perceptron and Radial networks [4]. The differences between these models may relate to the type of structure, type of learning (with or without supervision), method of information processing (feed forward or feed backward) and type of training (back propagation).

**Modeling Mobile Phone Selection:** The aim of this research is modeling the relationship between mobile phone selection and attributes of mobile phone. Therefore, the influential attributes of mobile phone, enter the model as input variables and according to these variables, brand variables and the price of the mobile phone are determined with two distinct models. In fact, the purpose is to classify brand and price variables and determine the influential input variables. To do the modeling two method of discriminant analysis and neural networks are used and at the end the result of these two models are compared to determine the power of each of these tools by classifications. Considering that in classification, probabilistic neural networks in comparison to the other models of neural networks, showed greater power [5], the used neural network is a kind of probabilistic neural network (PNN). To extract the influential variables, questionnaire was used, that was answered by 120 mobile phone users in Iran in Qom city. According to he analyzed sample, four types of mobile phones Nokia, Sony Ericson, Samsung and others for brand and five price ranges including 100 thousand

Tooman, between 100 to 200 thousand Tooman, between 200 to 300 thousand Tooman, between 300 to 400 thousand Tooman and higher than 400 thousand Tooman were selected.

#### Research Purpose:

- To determine level important of performance attributes, entertainment attributes, technological attributes and appearance attributes on selection and purchase
- To determine the relationship between attributes of mobile phone and the selected mobile phone to model it by using discriminant analysis and probabilistic neural network.
- To examine the two models to examine power of the neural networks in comparison with the discriminant analysis method.

#### Research Questions:

- How significant are the attributes of mobile phone include performance attributes, entertainment attributes, technological attributes and appearance attributes on evaluation and selection of mobile phone?
- Which attributes of mobile phone are more influential on evaluation and selection band of mobile phone ?
- Which attributes of mobile phone are more influential on evaluation and selection price of mobile phone ?

#### The Primary Input Variables for the Brand Input:

Calendar, calculator, alarm clock, initial memory capacity, increasable memory capacity, battery, accessories, guaranty, solidity, antenna, user-friendly keyboard, persion language, size, weight, size of screen, Color screen, record and play video, game, MP3 player, camera, radio, TV, Bluetooth, software, internet, sound quality, camera model, mobile phone style, mobile phone color and price of mobile phone.

#### The Primary Input Variables for the Price Input:

Calendar, calculator, alarm clock, initial memory capacity, increasable memory capacity, battery, accessories, guaranty, solidity, antenna, user-friendly keyboard, persion language, size, weight, size of screen, Color screen, record and play video, game, MP3 player, camera,

radio, TV, Bluetooth, software, internet, sound quality, camera model, mobile phone style, mobile phone color and brand of mobile phone.

#### Parameters in Neural Network Included the Following Issues:

- Type of neural network: probabilistic neural network(PNN)
- Learning function: Sigmoid
- Number of layers are 3 layers: an input layer, a hide layer and an output layer
- Training rate: 0.001
- Algorithm of learning: quick propagation
- Quick propagation coefficient: 1.76
- Stop training until to reach 0.0000001 in network MSE

We use SPSS15 software for dicriminant analysis method and for neural network method, we use Neurointelligence2.2.

## RESULTS

After the entrance of primary variables into the software the influential variables were identified by using discriminant analysis method and based on these variables the percentage of prediction were determined. In addition, by using probabilistic neural network method the primary variables entered the network that were trained by the use of a neural network sample of 120 and the influential variables were identified in Table 3 the results of the discriminate analysis method and neural network are shown. As it can be seen neural networks in comparison with discriminant analysis method, have greater prediction power. In addition, neural network needs less input variables for prediction than discriminant analysis method does. The influential variables and the percentage of significance were identified in each one of the variables of brand and price and then they are shown in the Table 1, 2. Final input variables of the neural networks are a set of final input variables of the discriminant analysis method in all of the following cases. The outstanding researchers [6-9] have compared prediction power of neural networks with discriminant analysis. All of the researchers have found that neural networks, work better than discriminant analysis. In this research, also it is considered as output of neural network.

Table 1: Final influential variables on brand selection

Row	Variable	Significant percentage
1	Style of mobile	42.1
2	Color of mobile	18.8
3	price	11.3
4	radio	6.5
5	camera	5.5
6	software	3.9
7	garanty	3.7
8	calender	2.9
9	game	2.8
10	MP3 record and play	2.6

Network with 4-9-18 strucure with 10 variable, iterations: 690

Table 2: Final influential variables on price selection

Row	Variable	Significant percentage
1	Brand	19.2
2	Style of mobile	17.5
3	Color of mobile	16.6
4	Initial memory	10.7
5	Reminder	9.6
6	Internet	8.7
7	Weight	7.6
8	Persion language	5.1
9	MP3 record and play	3.1
10	Solidity	1.9

Network with 5-10-21 strucure with 10 variable, iterations: 915

Table 3: Comparison of output variables in neural networks and discriminant analysis

Function variable	Primary input variables	Final Influential input variables	
		Neural network model	Discriminant analysis model
Brand	Calendar, calculator, alarm clock, initial memory capacity, increasable memory capacity, battery, accessories, guaranty, solidity, antenna, user-friendly keyboard, persion language, size, weight, size of screen, Color screen, record and play video , game, MP3 player, camera , radio, TV, Bluetooth, software, internet, sound quality, camera model, mobile phone style, mobile phone color and price of mobile phone	Mobile phone style 'mobile phone color 'price 'radio 'camera software, 'guaranty 'calendar 'game 'MP3 record and play	Calendar, initial memory capacity, increasable memory capacity, battery, accessories, solidity, antenna, user-friendly keyboard, persion language, size, weight, size of screen Color screen, record and play video, game MP3 player, camera , radio, TV, Bluetooth, software, internet sound quality, camera model, mobile phone style, mobile phone color and price of mobile phone.
Price	Calendar, calculator, alarm clock, initial memory capacity, increasable memory capacity, battery, accessories, guaranty, solidity, antenna, user-friendly keyboard, persion language, size, weight, size of screen, Color screen, record and play video, game, MP3 player, camera, radio, TV, Bluetooth, software, internet, sound quality, camera model, mobile phone style, mobile phone color and brand of mobile phone	Brand of mobile phone mobile phone style, mobile phone color, initial memory capacity, alarm clock, internet, weight, persion language, MP3 recorder and player, strong	calendar, alarm clock, initial memory capacity, battery accessories, guaranty, strong, antenna, calculator, increasable memory capacity, accessories, guaranty, solidity, antenna, persion language, size, weight, mobile phone color ,mobile phone style size of screen, Color screen, record and play video, MP3 player, camera, radio, software internet, sound quality, camera model and brand of mobile phone

Table 4: Comparison of neural network and discriminant analysis in variables and percent of anticipation

Function variable	Number of Primary input variables	Neural network model		Discriminant analysis model	
		Number of Final input variables	Percentage of anticipation	Number of Final input variables	Percentage of anticipation
Brand	30	10	87.1	29	79.7
Price	30	10	84.8	24	79.3

## DISCUSSION AND CONCLUSION

Table 1 and Table 2 show attributes of mobile phone that are most influential on the selection of brand and price of mobile phone. As it is evident in Table 1 style of mobile phone and color of mobile phone have most importance in the selection of brand and after these attributes price has most importance. But in As it is evident in Table 2 brand has most importance and after that style of mobile phone and color of mobile phone have most importance in the selection of price. In each of these table 10 influential attributes on brand and price are listed.

As it is evident in Table 4 neural networks are more powerful than discriminant analysis in anticipation for classification, also neural network needs less input variables than discriminant analysis for anticipation.

### Answers to Research Questions:

- How significant are the attributes of mobile phone include performance attributes, entertainment attributes, technological attributes and appearance attributes on evaluation and selection of mobile phone?

To examine level importance attributes are divided in 4 groups performance, entertainment, technological appearance attributes and then by friedman test appearance attributes has first importance and entertainment attributes has less importance.

- Importance of mobile phone attributes in each group

For this purpose we use T-TEST in comparison with a number 3

$$\begin{cases} H_0: \mu \leq 3 & \text{Attribute is not important} \\ H_1: \mu < 3 & \text{Attribute is important} \end{cases}$$

**According to Averages:** antenna with 4.40 average, solidity with 4.11 average from performance attributes, style with 4.14 average and color screen with 4.09 average from appearance attributes, camera with 4.08 from

entertainment attributes, sound quality with 4.30 average, Bluetooth with 4.1 average, camera model with 4.04 average from technological attributes have very importance to very much importance. Reminder, initial memory, increasable memory capacity, accessories, guaranty, persion language, size, weight, size of screen, record and play video, MP3 player and software have average importance to very importance, calendar, calculator, game, radio, TV and internet have les importance.

- Which attributes of mobile phone are more influential on evaluation and selection band of mobile phone ?

According to the output of neural network model: 'mobile phone style 'mobile phone color 'price 'radio 'camera ' software, 'guaranty 'calendar 'game 'MP3 record and play have the most influential role in the selection of brand of mobile phone.

- Which attributes of mobile phone are more influential on evaluation and selection price of mobile phone ?

According to the output of neural network model:brand of mobile phone mobile phone style, mobile phone color, initial memory capacity, alarm clock, internet, weight, persion language, MP3 recorder and player, solidity play the most influential role in the selection of price of mobile phone.

**Administrative Suggestion:** Designers and producers can use the results of the study as input to mobile phone design and production and marketing but it is better to do this research geographically. The approach taken in the analysis will also be helpful in identifying specific attributes that designers can focus on.

**Suggestion for Future Researches:** This research because of sample and time limitation neural network modeling based brand and price were done separately. Consider a complete model of mobile phone as out put in future researches about out put of neural network.

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