Marketing a web-site using a fuzzy logic approach

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Abstract: - This paper is aiming to use the fuzzy logic approach in analyzing a web-site marketing decisions. In the last years fuzzy mathematics and fuzzy logic changed the perspectives in many business related areas such as management, market research or customer segmentation. I am using these new findings to enhance the understanding of customer environment and to provide a solution to optimize the way a web-site is present in www-market. Accessing information about site visitors is instant, therefore, a marketer has the possibility to use these informations so that he can provide the best user experience before any page is displayed. A fuzzy logic model is considered and an example brings forward the benefits of fuzzy reasoning. The fuzzy model proves to be a faster, more intuitive and flexible tool to understand and respond to customer behavior.

Key-Word: - fuzzy logic, marketing, retention, site optimization, fuzzification, fuzzy inference, defuzzification

1 Introduction

Only in December 2009, in Romania, there were more then 302 millions visits and 1,63 billion pages viewed for top 1000 Romanian web-sites [1] [2]. In Top 10 there are one video hosting site, two e-commerce sites and three rich media content sites. For all these web 2.0 sites the quality of the user experience is paramount.

Marketing a site is a two step process. The first one will try to bring as many visitors as possible. Different marketing techniques will help to complete this step: banners on other web sites, pay-per click (like sponsored links in Google), database subscriptions, e-mail campaigns, etc. The second step will aim to keep the coming visitors interested and to make them loyal to the web site. This can be achieved by promoting quality content in a friendly environment. The friendly environment is defined by how the site is trying to display the content and how the end user will see it.

This paper will provide a way to increase the quality of the environment by using a fuzzy logic approach. Fuzzy logic offers better responses for web site customer demands because the variables of the web site environment are dynamic and stochastic, therefore hard to capture them with binary logic approach.

2 Conceptual framework

Since their first use the fuzzy sets were defined as a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function which assigns to each object a grade of membership between zero and one [3]. The main difference between binary logic and fuzzy logic consist in the membership function. If in binary logic the answer for the question can be “yes” or “no” in fuzzy logic the answer can be anywhere between “yes” or “no”.

In order to solve problems using fuzzy logic the if-then rules must be defined to translate the input variables into output variables and an inference process must be used. The inference process has five steps: fuzzification of the data, applying the fuzzy operator, applying implication method, aggregating all outputs and defuzzification of the results.

The first step, **fuzzification**, will take the crisp numerical values of the inputs and determine the degree to which they belong to each of the appropriate fuzzy sets via membership function [4].

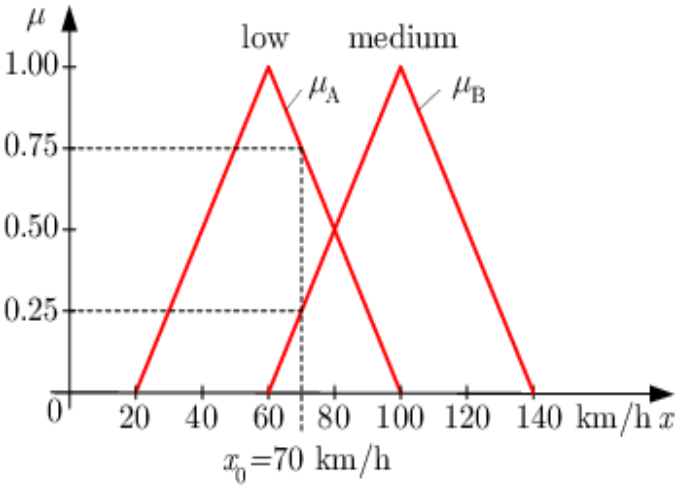

Fig.1 Fuzzification of a car speed [5]

For the example above the speed - 70 km/h - belongs to low speed with a grade (μ_A) of 0.75 and to medium speed with a grade (μ_B) of 0.25.

If the rule has more then one part for the antecedent (If resolution is x_1 **and** connection speed is x_x then…) **applying the fuzzy operator** will obtain a single truth value. If the connector for the propositions is "and" the most commonly used function is min (A,B) where A and B are the μ-values. If the connector is "or" the most commonly used function is max (A,B) where A and B are the μ-values. For example, given the statement: If the screen resolution is high (μ_A) and the connection speed is low (μ_b) then (…), suppose μ_A=0,6 and μ_b= 0.5 the truth value will be min(0.5,0.6)=0.5.

The **implication method** will be applied for each rule. A consequent is a fuzzy set represented by a membership function, which weights appropriately the linguistic characteristics that are attributed to it. The consequent is reshaped using a function associated with the antecedent (the single number obtained in the previous step). The input for the implication process is a single number given by the antecedent, and the output is a fuzzy set. The implication methods are the same methods used by the "and" method: min (that truncates the output fuzzy set) or prod (which scales the output fuzzy set) [4].

The forth step, **aggregating all outputs**, will take each rule output from previous step (inputs for this step) and using a method like max, probor (probabilistic OR) or sum (sum of the output sets) will deliver a fuzzy set for each variable (the output of this step).

The last step, **defuzzification**, will translate the fuzzy set from the previous step into a crisp value. There are five methods to achieve this: centroid, bisector, middle of maximum, smallest of maximum, and largest of maximum. Considering the aggregate fuzzy set a plate of equal density the centroid method will deliver the x value where the plate will be in balance. With the same example, the bisector method will deliver the x value which is dividing the plate in two equal areas. The middle of maximum will deliver the average of the maximum value, the smallest of maximum will output the smallest x value for the maximum value of the fuzzy set and the largest of maximum will deliver the largest x for the maximum value of the fuzzy set.

3 Problem statement

A web site can instantly access information regarding display resolution (Fig.2) and connection speed (Fig.3).

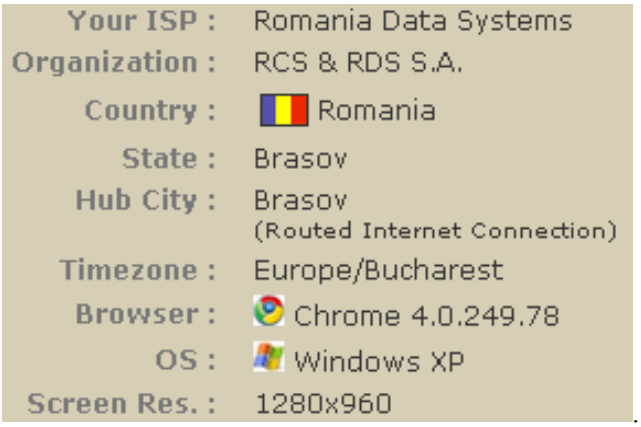

Fig.2 [6]

The content of the web-site and the site design can be decided before displaying the first page. Given the screen resolution and the average speed connection it is possible to choose how many site elements (pictures, videos, etc.) will be downloaded on the visitor computer. Because resolution and speed are dynamic variables and, more, connection speed is an inexact variable, fuzzy logic can solve the problem in a proper manner. The input variables will be: screen resolution and connection speed. The output variable will be the number of elements to be displayed on first page.

Fig.3 [7]

4 Solution

The steps described before, in Conceptual framework section, will guide the development of an appropriate fuzzy model. The if-then rules will be set. Display resolution and connection speed will have three fuzzy sets: low, medium, high. Number of elements will have the same fuzzy sets attached. From crisp values a fuzzification process will be applied. Then, applying the fuzzy operator, we'll obtain the result of the antecedent of that rule. Using the implication method a fuzzy set will be obtained. All the fuzzy sets are aggregated into one that will pass a defuzzification process. As an example we will use the data provided by Fig.2 and Fig.3.

4.1 If-then rules

The following pattern is used: **If** display resolution (R) is low/ medium/high **and** connection speed (C) is low/medium/high **then** the number of elements displayed (E) is low/medium/high. Number of rules will be 3x3=9 rules. For each rule the result is captured in Table 1.

then E is		**If** R is		
		Low	Medium	High
and C is	Low	Low	Low	Medium
	Medium	Low	Medium	High
	High	Medium	High	High

Table 1 If-then rules

4.2 Fuzzification

A triangular membership function is used to obtain fuzzy sets from crisp data. For display resolution the product between the horizontal and vertical resolution is the crisp value. The fuzzy sets are: low = [0,960000], medium = [0,1440000] and high = [960000,∞].

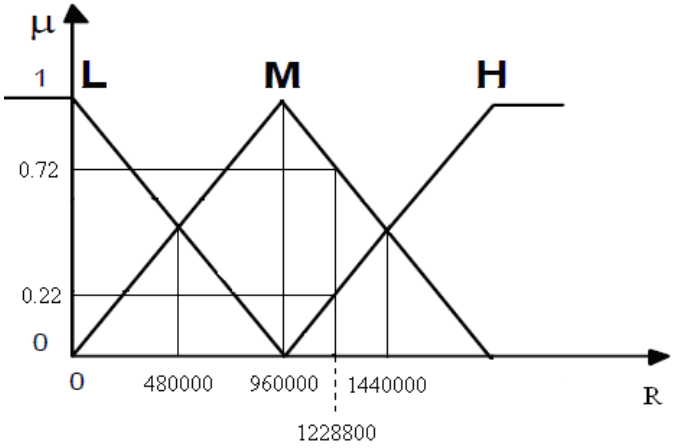

Fig.4 Screen resolution fuzzy sets

In Fig.2 the screen resolution is 1280x960=1228800. This resolution will have: μ_L=0, μ_M=0.72, μ_H=0.28. It means that this resolution does not belong to Low fuzzy set, belongs to medium fuzzy set in a grade of 0.72 and to high fuzzy set in a grade of 0.28.

For connection speed the fuzzy sets are: low = [0Mb/s,10Mb/s], medium = [0Mb/s,20Mb/s] and high = [10Mb/s, ∞].

In Fig.3 the average connection speed for the ISP is 17.01. For this value the connection speed will have μ_L=0; μ_M=0.30 and μ_H=0.70. The results are showed in Fig.5.

The fuzzification for number of elements is using the following fuzzy sets: low = [0, 30], medium = [0,60] and high = [30, ∞]. The numbers represent the elements loaded when a user accesses a web site. In Fig.6 the fuzzy sets for the output of the problem are showed.

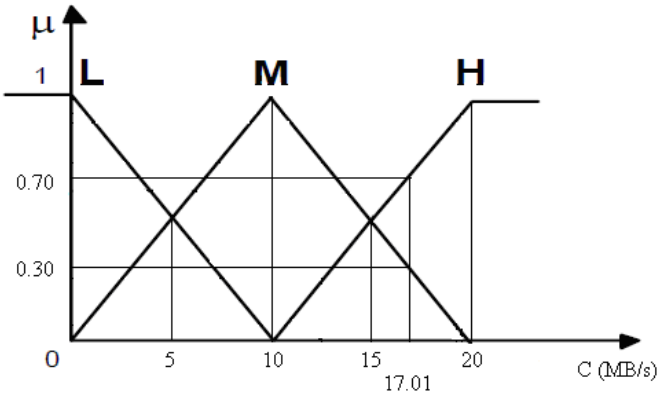

Fig.5 Connection speed fuzzy sets

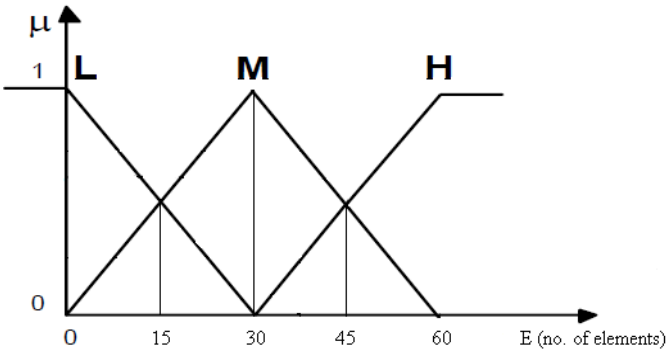

Fig.6 Number of elements fuzzy sets

4.3 Apply fuzzy operator

Because the rule connector is "and" we will use the "min" method. In Table 1 low, medium and high values are replaced with the values obtained after fuzzification. The result for all the nine rules is:

then E is min(R,C)		**If** R is		
		0	0.72	0.28
and C is	0	0 (Low)	0 (Low)	0 (Medium)
	0.30	0 (Low)	0.30 (Medium)	0.28 (High)
	0.70	0 (Medium)	0.70 (High)	0.28 (High)

Table 2 Fuzzy operator application

For our example six rules have the result of fuzzy operator equal to zero. Therefore only four rules will qualify for next step.

4.4 Apply implication method

The implication method selected is min. Excepting the rules with μ=0, we will use the values from Table 2 to determine the result of implication. The output will be the fuzzy set described by the rule and by the values from the Table 2.

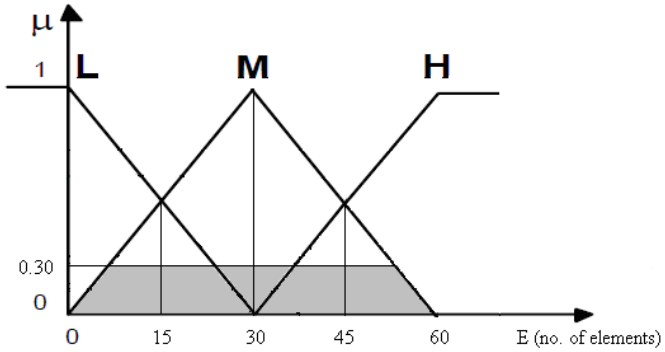

Fig.7 Implication for If R is medium and C is medium μ=0.30

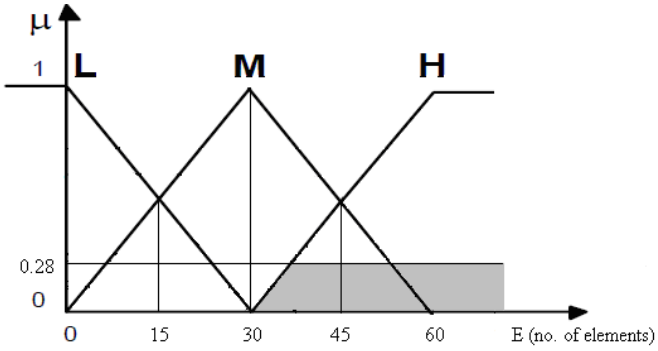

Fig.8 Implication for If R is high and C is medium μ=0.28

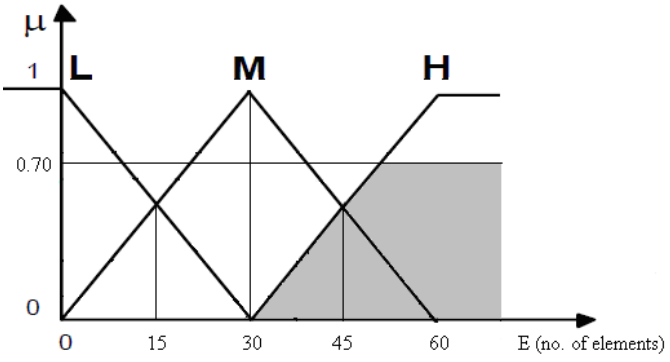

Fig.9 Implication for If R is medium and C is high μ=0.70

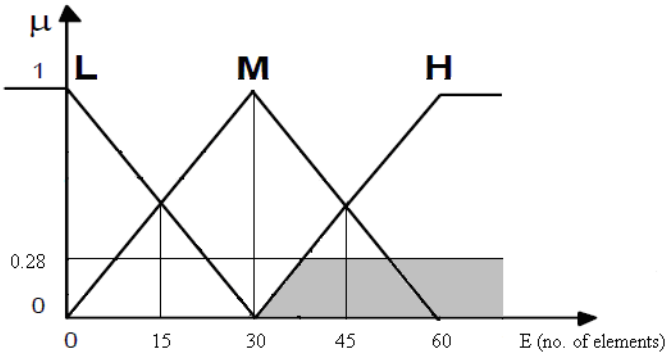

Fig.10 Implication for If R is high and C is high μ=0.28

4.5 Aggregate all outputs

Using the max method the final fuzzy set is obtained. All four previous graphics will be converted in one by superposing them.

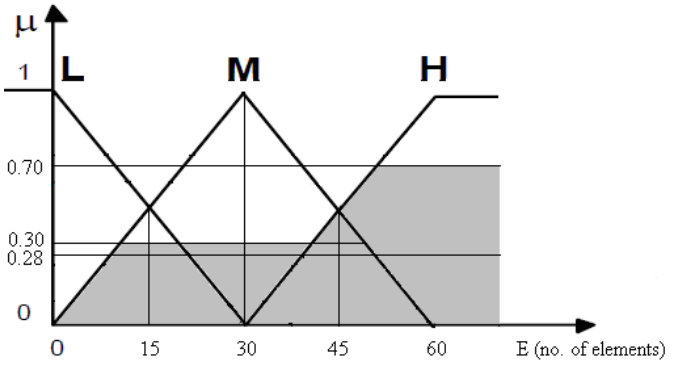

Fig.11 Aggregated fuzzy set

4.6 Defuzzification

Smallest of maximum will be used to obtain the crisp value from the fuzzy set above. The smallest E point where μ has the biggest value (μ=0.70) is the intersection of H line with μ=0.70.This corresponds to E=53.33. Therefore we can agree that the optimum solution for the configuration presented in problem statement section is to display a number as close as possible to 53 elements on the first page.

5 Conclusion

A practical application of the fuzzy logic has been described. All the necessary steps to achieve a fuzzy logic model were detailed and the example provided a clear look on how fuzzy logic works.

In world-wide-web environment access to information is easy and fast and information can be easily archived, therefore it is possible to segment the customers (visitors) using different attributes of the equipment they use and their interests. In this paper two characteristics of the visitors were enough do develop a model suitable for every visitor of the site.

The fuzzy logic approach proves to be an easy and intuitive way to deal with complex and dynamic information. It can answer questions even if the information is not complete and has the resources to become a powerful tool for marketing experts.

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