UN MÉTODO PARA CARACTERIZAR LOS ESTUDIANTES UTILIZANDO EL MODELO LINGÜÍSTICO VIRTUAL

A METHOD FOR THE CHARACTERIZATION OF STUDENTS USING VIRTUAL LANGUAGE MODEL

MSc. Osiris Perez Moya, Ing. Yadián García Ojito*
Universidad de las Ciencias Informáticas. Cuba. Carretera a San Antonio de los Baños km 2 ½, Reparto Torrens. Boyeros. Ciudad de La Habana. C.P.: 19370
* operez@uci.cu, cell-phone +5352385795

RESUMEN
Se propone la utilización del modelo lingüístico virtual como base para la definición de una técnica para analizar los criterios que puedan tener varios profesores sobre el desempeño de un estudiante y a partir de estos elementos por separados llegar a un consenso colectivo que permita caracterizar el estudiante. Se parte que ya deben existir los criterios que serán analizados por los profesores o evaluadores. Se describe en qué consiste el modelo seleccionado y cómo aplicarlo en la caracterización de los estudiantes a partir de información imprecisa que emite el personal que los analiza y que puede ser experto o no en la temática.
Palabras claves: *análisis lingüístico virtual, caracterización de estudiantes, evaluación de estudiantes.*

ABSTRACT
The use of virtual linguistic model is proposed as the basis for the definition of a technique to analyze the criteria that may have several teachers on student performance and from these separate elements reach a collective consensus to characterize the student. Are already required to be part of the criteria that will be analyzed by teachers or evaluators. It describes what the selected model and how to apply in characterizing students from issuing inaccurate information staff analyzes and can be an expert in the subject or not.
Keywords*: evaluation of students, characterization of students, virtual linguistic analysis.*

INTRODUCTION

In assessing students it may be that the decision is implemented based on arguments uncertainty where information may be inaccurate or based on perceptions. In these cases the computational linguistic models help shape this knowledge (Rodriguez et al, 2010). This section focuses on defined decision problems under uncertainty, where people make decisions based on uncertain knowledge or perceptions.

For these cases the Linguistic Fuzzy modeling approach based on that knowledge Fuzzy Sets Theory by linguistic modeling, obtaining satisfactory results in these decision -making problems which are called Decision Making Language (TDL). In the linguistic modeling linguistic variables whose values are words or phrases defined in a natural or artificial language (Rodriguez et al, 2010) are used.

A linguistic variable is characterized by a syntactic value or label and a semantic value or meaning. The tag is a word or phrase belongs to a set of linguistic terms and the meaning of the label is given by a fuzzy subset in the universe of discourse. Thus, the words may be used to define a valid complex situation in which the use of precise numeric values may distort information (Rodriguez et al, 2010) option.

In an investigation by Rodriguez et al (2010) poses a linguistic variable can be expressed by the quintuple (H, T(H), U, G, M)

Where:

H is the variable name,

T (H) is the set of linguistic terms of M, that is, the set of names of linguistic values of M, where each value is noted as varying diffuse X which varies along the universe of discourse,

U is the universe of discourse associated with a base variable called u,

G represents the syntactic rule (grammar) to generate the names of the values of H and

M is the semantic rule for associating meaning M (X) to each element of H.

Universe of discourse is called the range of values that can take the elements that have the property expressed by the linguistic variable. Linguistic values are different classifications are made on the linguistic variable , so that each linguistic value will have a fuzzy subset associated for interpreting the different linguistic values as fuzzy subsets associated with specific linguistic variable (Rodriguez et al, 2010) .

The linguistic descriptors allow a linguistic variable to provide a source of information a few terms that can easily express their information or knowledge. The choice of the set of linguistic terms is related to the granularity of uncertainty (Bonissone, et al., 2011), namely, the cardinality of the set of linguistic terms used to express and represent information (Rodriguez et al, 2010).

Cardinality commonly used in the language models is usually an odd value, such as 7 or 9, not exceeding 11 or 13 tags. The middle term represents an evaluation of about 0.5, and the other terms are placed symmetrically about the middle point (Bonissone, et al., 2011). These classic cardinality values are based on the observation line of Miller on human capacity, which indicates that you can reasonably handle and remember about terms (MILLER, 1956).

DEVELOPMENT

In decision making under uncertainty using the language modeling has provided good results in treating such uncertainty (Rodriguez et al, 2010).

In the figure below you can see a basic outline of problem solving decision making (Rodriguez et al, 2010). This scheme consists of two phases (MEYER and ROUBENS, 2007):

1. *Phase aggregation:* in which a set of preference values of different experts on a set of shared values of each alternative are transformed.
2. *Phase Operating:* a collective value once obtained a selection process is applied to obtain a set of alternative solutions to the problem.

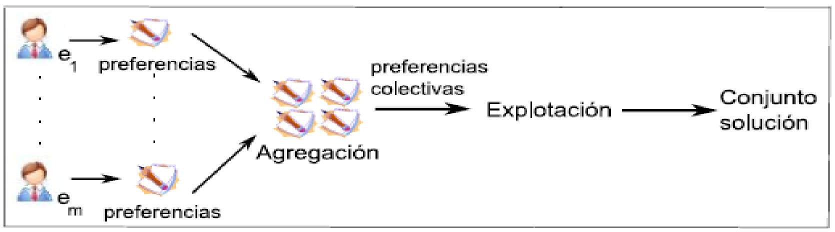

Figure 1. Schematic of a decision-making problem as (RODRIGUEZ et al, 2010).

RODRIGUEZ and others (2010) present a literature review that *a basic problem of making linguistic multi-expert decision involves choosing among a set of alternatives,* $X = \{x_1, \ldots, x_n\}$ *on a set of experts* $E = \{e_1, \ldots, e_m\}$ *express their preferences,* $\{x_i^j \in S \; i = 1, \ldots, n \; y \; j = 1, \ldots m\}$ *a set of linguistic terms* $S = \{s_0, \ldots, s_g\}$ *, to select the best alternative to the problem. Values* $x_i^j \in S$*, are linguistic labels whose semantics are fuzzy sets defined in*$[0, 1]$.

In the literature there are different models for computing with words processes required in problem-solving models of TDL. The linguistic preference modeling involves the need to perform operations that have defined linguistic labels aggregation operators, comparison, negation, etc. on linguistic information, being the two most common models based on the extension principle and symbolic models (Rodriguez et al, 2010).

- Based on the extension principle model operates on the fuzzy numbers that define the semantics of the linguistic terms (TONG and SHAPIRO, 1985), (Shendrik and TAMM, 1985), (SILOV and Vilenchik, 1985) and (Pedrycz et al., 1991).

– The symbolic model considers an ordinal scale labels. This model is posed on the use of max-min (YAGER, 2008) and operators (Jowers *et al.,* 2007) and, under the use of the convex combination of indexes tags (DELGADO et al., 2006).

This contribution focuses on the study of some symbolic models that are easier to interpret, such as the 2 - tuple linguistic model (GACTO *et al*, 2011), (PORCEL and Herrera - Viedma, 2010) and (ALONSO *et al.*, 2010), the Virtual linguistic model (GENÇ *et al*., 2010) and (XU and XIA, 2012) and 2 - tuple linguistic model proportional (WANG and HAO, 2006). The objective pursued is to analyze and compare the role of these computational models in the TDL for the treatment of problems based on perceptions in decision analysis , to be included as part of the evaluation or characterization of students. These models can also be included in making the right choice when you have to apply more than one and there is a decision about which is correct.

Zadeh suggests that the use of language modeling and hence computing with words processes is mainly suitable in the following situations (ZADEH, 2008) and (ZADEH, 2006):

– When the available information is too imprecise to justify the use of numerical values,

– When imprecise information can be used to achieve robust, low-cost solution to a good interpretation of reality.

The linguistic symbolic computational model uses the ordered structure of the set of linguistic terms $S = \{s_0, s_1, \dots\ s_g\}$ where $s_i < s_j$ if $i < j$ to perform computing processes. This computational model intermediate results of operations are numerical values $\gamma \in [0, g]$ they have no semantic or syntactic interpretation, so they must be approximated at each step of the computational process by an approximating function $app_2 :\ [0, g] \rightarrow \{0, \dots, g\}$, you get a numeric value that indicates the index of the linguistic term associated with that outcome in the initial set of linguistic terms $s_{app2(\gamma)} \in S$ (RODRÍGUEZ *et al*, 2010).

MILLER (1956) identified a number of operators to operate symbolically, as maximum, minimum and denial.

Is $S = \{s_0, \dots, s_g\}$ a set of linguistic terms and is s_i , $s_j \in S$ two linguistic terms.

Maximum $max(s_i, s_j) = s_i\ si\ s_i \geq s_j$

Minimum $min(s_i, s_j) = s_j\ if\ s_i \leq s_j$

Negation $neg(s_i) = s_{g-i+1}$

In addition to the comparison operators:

If $i < j$, then $s_i < s_j$

If $j > i$, then $s_j > s_j$

If $i = j$, then $s_i = s_j$

The linguistic 2- tuple model aims to improve the accuracy of computing with words processes and to express symbolically any outcome in the universe of discourse. This computational model was introduced in order to improve accuracy of computing with words processes and to express symbolically any outcome in the universe of discourse (Rodriguez et al, 2010).

The Model 2 - tuple linguistic proportional: From this conception of a new model for linguistic information representation, which uses as a basis for February 1 - tuple representation is developed. This model was introduced by Wang and Hao (WANG and HAO, 2006) in order to extend and generalize the two - tuple linguistic model.

Despite the improvement that involved the introduction of linguistic 2- tuple model in the operative words, Xu presented a new computational model for working with fuzzy linguistic approach improved accuracy with respect to the classical symbolic model, in addition to increasing number of operational laws that can be applied to linguistic information: the virtual linguistic model (GENÇ et al, 2010) and (XU and XIA, 2012).

Since one of the objectives of introducing the virtual Xu linguistic model was to increase operational laws that could be applied to the processes of computing with words defined the representation of linguistic information in ways that spread the values of a set of linguistic terms discrete $S = \{s_0, \ldots, s_g\}$ a continuous set of terms $\bar{S} = \{s_\alpha | s_0 < s_\alpha \leq s_g, \alpha \in [0, g]\}$, such that if $s_\alpha \in S$ s_α is an *original* linguistic term, and otherwise $s_\alpha \in \bar{s}$ y $s_\alpha \notin S$ linguistic term called *virtual*. The virtual linguistic terms have no assigned any semantic or syntax (XU, 2012) and (XU and XIA, 2011).

The original linguistic terms are used to express individual preferences, while virtual linguistic terms appear as a result of operations on the first.

To increase the number of operational laws computing processes with words and obtain accurate results, Xu defined a set of operations (XU, 2012) and (XU, 2011) in this model.

Following the example of (Rodriguez et al, 2010) is shown to explain the use of this model.

Assuming that a small company wants to renew its employees computers sales, P = {p_1, p_2, p_3, p_4}. This asked for their opinions on which of the various alternatives that have better fits your needs. The alternatives are:

Table 1. Criteria to evaluate sales employees.

X_1	X_2	X_3	X_4

PC	Portable	Netbook	Imac

Since employees are not computer experts, their preferences are strongly marked by their perceptions and include uncertainty due to lack of knowledge. Therefore, these preferences are expressed linguistically in the set S = {S_0: nothing, S_1: verylittle, S_2: little, S_3: medium, S_4: high, S_5: veryhigh, S_6: total}. Each employee provides a vector of preferences:

Table 2. Decision matrix preference of each of the experts for each criterion.

		alternatives			
	μ_{ij}	X_1	X_2	X_3	X_4
experts	p_1	little	medium	medium	little
	p_2	medium	little	verylittle	high
	p_3	high	verylittle	medium	medium
	p_4	high	high	little	little

To solve this problem the resolution scheme shown in a previous figure consisting of two phases, the phase of aggregation and exploitation phase is used. In both computational models used in the process of aggregating the operator of the arithmetic mean, and in the process of operating the alternative with higher overall score is selected. Applying the formula to calculate the arithmetic mean the following results:

Equation 1. Arithmetic defined by (XU, 2012) y (XU y XIA, 2011).

$$\overline{x}^e = \frac{\sum_{i=1}^{n} s_i}{n}$$

Table 3. Results obtained by applying the virtual linguistic model.

X^e_1	X^e_2	X^e_3	X^e_4
$S_{3,25}$	$S_{2,5}$	$S_{2,25}$	$S_{2,75}$

The steps used in obtaining these results, if you apply in the evaluation /characterization of students, should be sorted by criteria that would be the priority with which will be discussed or that they should put more emphasis on the differential treatment.

This ordination technique can also be used to implement the actions defined for the resolution of contingencies, especially when you have more than one action to apply. The use of virtual linguistic model helps define what the action is that the collective preference is strongest.

Justification for the use of virtual linguistic model

The criteria taken into account in selecting the virtual linguistic model were: the type of information representation, the type of conceptual model, model accuracy and ease of interpretation. The criteria for each of these are shown.

Type of information representation

- To represent information, model 2-tuple fuzzy maintains a representation of linguistic information, because the results are assigned a syntax and semantics as defined by the Linguistic Fuzzy Approach.
- The Virtual model gets a numeric result that is not assigned or syntax or semantics, so there remains the basis of the Fuzzy Linguistic Approach.
- The Model 2-tuple also maintains a fuzzy proportional representation, because it uses the ratio of two consecutive linguistic labels to represent the result (RODRIGUEZ *et al*, 2010).

Type computational model

- The 2-tuple model presents symbolic operations and transformation functions whose results are assigned a syntax and semantics.
- However, the model presents Virtual operations whose results are numerical values that may be outside the universe of discourse, so that cannot be represented linguistically, as they are not assigned any semantic or syntax.
- The proportional Model 2-tuple also proposes symbolic operations and transformation functions as model 2-tuple, however the results are assigned syntax only because their semantics is not clearly defined (RODRIGUEZ *et al*, 2010).

Precision

- The Model 2-tuple can only get values in the universe of discourse of the variable, and ensures accuracy when the label set is symmetrical and evenly distributed.
- The Virtual model is accurate in any set of labels; it does not use any semantics, besides being able to obtain values outside the universe of discourse of the linguistic variable.
- As model 2-tuple, model 2-tuple can only obtain values proportional within the universe of discourse, and ensures accuracy when the support of all labels is the same (RODRIGUEZ *et al*, 2010).

Interpretability

- The Model 2-tuple provides qualitative results easy to understand.

– However, the Virtual model gets pseudo-linguistic values difficult to understand because having neither syntax nor semantics; its only use is the management.
– The proportional Model 2-tuple is more complex model 2-tuple because it uses four values to represent a single assessment (RODRIGUEZ *et al*, 2010).

This analysis highlights that the computational model of model 2-tuple, is the only model based on Fuzzy Linguistic Approach because it keeps a syntax and semantics to represent a diffuse and operate with linguistic terms. So it is appropriate for the treatment of uncertainty, and near the cognitive model of humans. While Virtual Models 2-tuple and are not proportional symbolic models as defined by the authors (XU, 2012) y (XU y XIA, 2011) y (WANG y HAO, 2006), because they remain the basis of Fuzzy Linguistic Approach. However, although two-tuple model is accurate in computation processes words, limitations remain in operational processes, since it is not possible to perform arithmetic operations set symbolically. The table below summarizes the above stated:

Table 4. Summary table study of symbolic models, taken from (RODRIGUEZ *et al*, 2010).

	2-Tuple	***Virtual Linguistics***	*Proportional 2-Tuple*
Representation	Fuzzy	No Fuzzy	No Fuzzy
Computational Model	Linguistic	No Linguistic	Linguistic
Precision	Tags equidistant	Always no Semantic	Same Amplitude
Comprehension	Easy to understand	Useful in Ordinations	Understandable

Virtual description language model in the characterization/evaluation of students

In the process proposed to characterize/assess students virtual linguistic characterization technique based on the proposed virtual linguistic model used by XU (2011) and extended by XIA y XU (2011), XU y XIA (2012), YAGER (2008) y, ZADEH (2008) (2006). Here are the steps for applying the proposed technique:

1. Define the set of member who will participate in the virtual linguistic characterization of students.
2. Define the set of linguistic labels to use.

From this step is a set of people $E = \{e_1, \dots, e_k\}$ characterizing/evaluating a particular group of students from their criteria based on experience (P) and criterion (I), where the set of tags P = I and is represented as:

$\mathrm{S} = \{\mathrm{s}_1 = \text{veryHigh (MA)},\ \mathrm{s}_2 = \text{Highfairly (BA)},\ \mathrm{s}_3 = \text{High (A)},\ \mathrm{s}_4 = \text{ moderate (M)},\ \mathrm{s}_5 = \text{Low (B)},\ \mathrm{s}_6 =$ $\text{veryLow MB}, s7 = \text{notApplicable (NA)}$

3. People involved in the characterization/evaluation issue their preferences on the criteria identified.

Table 6. Representation of individual preferences for each risk analyzed.

person	experience	criterion	experience	criterion	experience	criterion
1	$S_{\beta_1}^1$	$S_{\alpha_1}^1$	$S_{\beta_1}^2$	$S_{\alpha_1}^2$	$\boldsymbol{S_{\beta_i}^n}$	$\boldsymbol{S_{\alpha_i}^n}$

Where $S_{\alpha_i}^j$ the value is assigned to the criterion j by the person i.

$S_{\beta_i}^j$ is el valor asignado a la experiencia j by the person i.

4. A table like the one shown below the individual preferences of each expert for all criteria as collective preferences are represented,

Table 7. Representation of collective preferences for risks discussed.

person	experience	criterion	experience	criterion	experience	criterion
1	$S_{\beta_1}^1$	$S_{\alpha_1}^1$	$S_{\beta_1}^2$	$S_{\alpha_1}^2$	$S_{\beta_1}^j$	$S_{\alpha_1}^j$
2	$S_{\beta_2}^1$	$S_{\alpha_2}^1$	$S_{\beta_2}^2$	$S_{\alpha_2}^2$	$S_{\beta_2}^j$	$S_{\alpha_2}^j$
3	$S_{\beta_3}^1$	$S_{\alpha_3}^1$	$S_{\beta_3}^2$	$S_{\alpha_3}^2$	$S_{\beta_3}^j$	$S_{\alpha_3}^j$
…	…	…	…	…	…	…
i	$S_{\beta_i}^1$	$S_{\alpha_i}^1$	$S_{\beta_i}^1$	$S_{\alpha_i}^1$	$S_{\beta_i}^j$	$S_{\alpha_i}^j$

5. Effective operator defined by (XU, 2011) for virtual linguistic multiplication,

Equation 1. Multiplication virtual language given by (XU, 2011).

$$s_\alpha \otimes s_\beta = s_\beta \otimes s_\alpha = s_{\alpha\beta}$$

Collective preference for each criterion is evaluated by the formula obtained from the arithmetic average is calculated proposed Xu(2011).

Equation 2. Formula for calculating the collective preferences of the criteria.

$$\boldsymbol{\overline{r_n} = \frac{1}{n}\sum_{i=1}^{j} S_{\alpha_i}^j \otimes S_{\beta_i}^j}$$

Where $\bar{r}$ is the value of the collective preference for criterion n.

j is the number of criteria examined.

Table 8. Calculation of the virtual collective assessment of the criteria considered.

person	experience	criterion	experience	criterion	experience	criterion
1	$S_{\beta_1}^1$	$S_{\alpha_1}^1$	$S_{\beta_1}^2$	$S_{\alpha_1}^2$	$S_{\beta_1}^j$	$S_{\alpha_1}^j$

2	$S^1_{\beta_2}$	$S^1_{\alpha_2}$	$S^2_{\beta_2}$	$S^2_{\alpha_2}$	$S^j_{\beta_2}$	$S^j_{\alpha_2}$
3	$S^1_{\beta_3}$	$S^1_{\alpha_3}$	$S^2_{\beta_3}$	$S^2_{\alpha_3}$	$S^j_{\beta_3}$	$S^j_{\alpha_3}$
…	…	…	…	…	…	…
i	$S^1_{\beta_i}$	$S^1_{\alpha_i}$	$S^1_{\beta_i}$	$S^1_{\alpha_i}$	$\boldsymbol{S^j_{\beta_i}}$	$\boldsymbol{S^j_{\alpha_i}}$
Virtual collective evaluation criteria					$\boldsymbol{\bar{r}_j = \frac{1}{n}\sum_{i=1}^{n} S^j_{\alpha_i} \otimes S^j_{\beta_i}}$	

6. Criteria obtained in the previous step are ordered.

Thus the criteria sorted according to linguistic criteria issued by those evaluating or characterize students obtained.

CASE

The following steps apply defined and described some results obtained by applying the technique. For this you have a group of people $\mathrm{E} = \{e_1, e_2, e_3, e_4, e_5\}$ they are asked their opinion on experience (P) and criterion (I) labels to evaluate P and I are:

$$\mathrm{S} = \{s_1 = \text{veryHigh (MA)},\quad s_2 = \text{Highfairly (BA)},\ s_3 = \text{High (A)},\ s_4 = \text{ moderate (M)},\quad s_5 = \text{Low (B)},\ s_6 = \text{veryLow (MB)}, s_7 = \text{notApplicable (NA)}\}$$

Once each person expresses their preferences on P and I, collective preferences are calculated.

Table 5. Representation of individual preferences for each element analyzed.

person	P	I	P	I	P	I	P	I	P	I	P	I
1	BA	A	A	A	MA	M	BA	A	BA	A	M	MA
2	M	A	MB	MA	BA	M	BA	M	A	MA	MB	A
3	M	MA	A	A	BA	A	A	A	BA	MA	A	MA
4	BA	A	BA	A	MA	A	MA	M	A	MA	A	A
5	BA	MA	BA	A	MA	M	BA	A	MA	A	A	A
$\boldsymbol{\overline{r_n}}$	$\overline{r_1} = \frac{1}{6}(s_6 + s_{12} + s_4 + s_6 + s_2) = \frac{1}{6}s_{30} = s_5$		$\overline{r_1} = \frac{1}{6}(s_9 + s_6 + s_9 + s_6 + s_6) = \frac{1}{6}s_{36} = s_6$		$\overline{r_1} = \frac{1}{6}(s_4 + s_8 + s_6 + s_3 + s_4) = \frac{1}{6}s_{25} = s_{4,17}$		$\overline{r_1} = \frac{1}{6}(s_6 + s_8 + s_9 + s_4 + s_6) = \frac{1}{6}s_{33} = s_{5,5}$		$\overline{r_1} = \frac{1}{6}(s_6 + s_3 + s_2 + s_3 + s_3) = \frac{1}{6}s_{17} = s_{2,83}$		$\overline{r_1} = \frac{1}{6}(s_4 + s_{18} + s_3 + s_9 + s_9) = \frac{1}{6}s_{43} = s_{7,17}$	

After obtaining the collective preferences evaluated criteria or elements is sorted. The order of the above example is as follows: R6, R2, R4, R1, R3 and R5.

In the virtual linguistic evaluation of individual criteria is reached consensus and collective judgment is determined. The results obtained, from the vagueness of the information available, that it can be used to get closer to reality. As of making assumptions, offers a way to perform calculations when available information is not sufficiently precise to justify the use of numbers.

CONCLUSIONS

In this paper the definition and description of the implementation of the virtual language model in the evaluation/characterization of the students was achieved, this allows can capture the students according to their performance or to work in the development of certain skills not yet completed. Elements that formed the basis for selection of this model to achieve greater consensus among those that emit criteria in the evaluation of students were described, and explains its use in a case.

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