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Neutrosophic causal modeling for analyzing the diffusion of the institutional culture: the case UNIANDES

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Abstract: The dissemination of culture is an activity assumed by teaching institutions. Knowing the cultural elements that characterize each nation allows to preserve the cultural heritage. However, quantifying this result represents a complex task to perform. This research proposes a solution to the problem posed with the design of a multicriteria method for the evaluation of cultural diffusion. The method uses neutrosophical numbers to model uncertainty. The proposal introduced the results in UNIANDES, Ibarra and it was found that it has a high rate of cultural diffusion.

Keywords: Diffusion of the culture; neutrosophic numbers; evaluation; multi-criteria.

1 Introduction

The culture encompasses all the contexts in which the life of an individual develops. For this reason, the institutional framework does not escape this fact. It is imperative, for the human species, to preserve and spread their culture. This allows transcending time to preserve roots and authenticity [1], [2].

Cultural diffusion is one of the three elements that make up heritage management (Research, Conservation / Restoration and Dissemination). Dissemination is a cultural Mediation Management between Heritage and Society [3].

There are several ways to transmit and preserve the culture. Attending to its versatility, immediacy, diversity and level of insertion in society; Information Technology and Communications (ICTs) is considered an ideal means for cultural dissemination [4], [5]. Under the guidance of the previous thought the investigation is developed [6], [7].

Knowing the level of cultural dissemination achieved by organizations represents a task little addressed by science. Based on the problem described above, it is proposed as the objective of the present investigation to develop a causal neutrosophic model for the analysis of cultural diffusion.

2 Preliminaries

This section describes the set of theoretical references necessary to facilitate the understanding of the proposal. ICTs are described in the context of cultural diffusion. Multicriteria methods are introduced in the context of the investigation. The Neutrosophic Cognitive Maps are characterized as an element of inference for the development of the present investigation. In addition, the theory of Neutrosophic numbers is introduced.

2.1 ICTs in the dissemination of culture

Currently, Information Technology and Communications (ICTs) are present in all areas of knowledge. That is why culture has also been an area in which its use has been introduced.

In the cultural context it is convenient to place the introduction of the concept of e-culture, which in principle is still one of many neologisms related to the new digital and technological paradigm that made fortune in a probably transitory way. Without intending to establish a canonical definition, it can be proposed that this concept applies to all cultural processes that are developed in studies through the network, in part or in its entirety.

Among the most used media to spread the culture are computers, televisions, portable players, radio, video games and Smartphone.

The computer: the contribution of this technology is practically unlimited. It reflects the trajectory of an institution. It can include the development of multimedia programs or educational games and the creation of computer tools such as web pages or wikis. The computer can also house digital documents, videos and images.

The television: allows the insertion of allegorical advertising spots to dates, events or relevant news of the institution that can be a way of spreading its culture. Using televisions in specific areas within the building occupied by the institution, a sequence of images, text and sound can be uninterruptedly projected for informational, advertising or dissemination purposes of specific aspects of the institution's internal life.

The portable player: contributes to the dissemination of informative audios, which can communicate a synthesis of the historical trajectory of the institution. It is useful in the history room or in spaces where elements of the entity's culture stand out, allow the results to be disseminated and that visitors or interested parties access that knowledge. In addition, it can help eliminate the language barrier by including audios in different languages.

The radio: represents one of the ideal ways to reach homes and thus raise awareness of relevant aspects about the institution, its achievements and its culture. In the same way, advertising spots related to dates, events or highlights of the institution can be used.

The game console: although it is a device used primarily by children and adolescents, it has the potential for cultural dissemination. Creativity and commitment could result in the development of educational games in which aspects of the institution's culture are discussed.

The Smartphone: a technology that has revolutionized the means of telephone communication. It provides almost all the functions of a computer, in a compact, agile and portable way. It is very present in the lives of individuals today. Its versatility allows it to be a synthesis of the previous technologies and incorporates them to a high degree. You can recreate the environment and scope of each of the above elements.

ICTs represent an important source for disseminating the cultural heritage of an institution representing an element to be measured by the institutions.

2.2 Diffuse Cognitive Map

The theory of Cognitive Maps allows to obtain a structure based on the most understandable knowledge. A cognitive map is characterized from a group of concepts and causal relationships between its nodes.The concepts represent variables that describe the system that is modeled in a specific domain.

Causal relationships denote connections between concepts. Each relationship has an associated sign that determines causal directionality. It is true that:

- If the sign of the connection is positive, then a variation in the concept of cause (initial concept) will cause a variation in the concept of effect in the same direction.
- • If the sign of the relationship is negative, then a variation in the concept of cause will cause a variation in the concept of effect in the opposite direction.

2.3 Neutrosophic classification

The neutrosophic groups are a blurred group generated. It let's being U an universe of speech, and M a group included in U[8], [9], [10].An element x of U is noted in respect of the set M as x(T, I, F). With the purpose of facilitating the application of a problem for making decisions and engineering is performed the proposal of the neutrosophic number of unique value (SVN)[11], [12], [13].

If **X** is a universe of speech. A SVN over X is an object of the way.

$$A = \{\langle x, u_A(x), r_A(x), v_A(x)\rangle : x \in X\}d \quad (1)$$

Where $u_A(x): X \rightarrow [0,1]$, $r_A(x), : X \rightarrow [0,1]$ y $v_A(x): X \rightarrow [0,1]$ $with$ $0 \leq u_A(x) + r_A(x) + v_A(x) :\leq 3$ for everything $x \in X$.

The interval $u_A(x), r_A(x)$ y $v_A(x)$ denote the membership on true, I do not know and false of X in A, respectively. Number SVN will express as A= (a,b,c), where a, b, $c \in [0,1]$, y + b + $c \leq 3$.

2.4 Neutrosophic Cognitive Map

A Neutrosophic Cognitive Map (NCM) is defined using a 3-tuple for each node (T, I, F) for each concept$C = \{C1, C2, C3, \dots, CN\}$ that represents the set of graph concepts [14], [15], [16].

Where

W: $(Ci, Cj) \rightarrow wij$It is a function that associates a causal value wij with each pair of neurons(Ci, Cj). This value wij denotes the direction and intensity of the edge that connects the concept Ci with the neuron Cj where the matrix of weights W defines the behavior of the system [16], [17], [18].

From the algebraic point of view the propagation phase of a stimulus is reduced to successive multiplications of the state vector by the weight matrix, until a stop criterion is reached [19]. Therefore, a variation in a concept can directly or indirectly affect the entire map.

NCMs do not exploit the advantages of Fuzzy Logic in the information propagation process, rather these principles are used during the construction of the map. In this way the concepts and relationships of the map are represented by diffuse variables expressed as linguistic terms [20],[21], [22].

Given its recurring nature, the system modeled by an NCM will evolve over time, where the activation of each neuron will depend on the degree of activation of its background in the previous iteration. Normally this process is repeated until the system stabilizes or reaches a maximum number of iterations [23].

Equation (2) summarizes this simulation process, which consists in calculating the state vector A over time, for an initial conditionA_0. Similarly to other neuronal systems, the activation of Ci will depend on the activation of neurons that directly affect the concept Ci and the causal weights associated with that concept.

$$A_i^{(t+1)} = f\left(\sum_{i=1;\, j\neq i}^{n} W_{ji} A_i^{(t)}\right) \qquad (2)$$

3 Proposed model to assess cultural dissemination

The proposed model consists of three fundamental activities: Selection of dissemination profiles, evaluation of alternatives and generation of recommendations based on the selection of the knowledge base of the cultural diffusion similarity profile. The figure 1 shows a schema with the general performance of the suggested method.

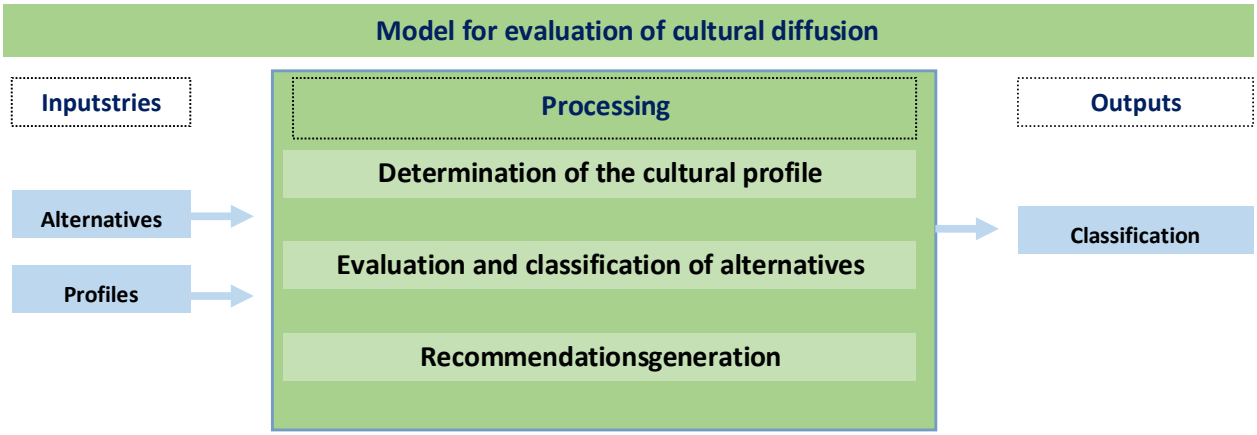

Figure 1. Main schema for performing the method.

In the following, it is presented the flow of works.

It is mainly based on the Cordon proposal as a recommendation`s system based on the knowledge, allowing to represent the linguistic terms and the indetermination by means of SVN numbers. The detailed description of each activity and the math model that support the proposal is presented below.

Activity 1. Determination of the cultural profile:

The creation of cultural profiles is expressed from the knowledge that institutions reflect on the object of study. Each alternative$a_i$will be described by a set of characteristics that will shape the cultural profile. As expressed in equation (3).

$$C = \{c_1, \dots, c_k, \dots, c_l\} \tag{3}$$

Once the evaluation criteria have been identified, the causal relationships between the manifestations are determined using a domain of values between [-1; 1], where 3 experts participated, the 3 Cognitive Neutrosophical Maps were obtained by adding the answers in a single result. Table 1 shows the adjacency matrix obtained as a result of the process.

Table 1: Resulting adjacency matrix

	$C_{1T, I, F}$	**$C_{2\ T, I, F}$**	**$C_{3\ T, I, F}$**	**$C_{4\ T, I, F}$**
$C_{1\ T, I, F}$	[0, 0,0]	[0.75, 0.5,0.25]	[0.5, 0.25,0]	[0.5, 0.25,0]
$C_{2\ T, I, F}$	[0.75, 0.5,0.25]	[0, 0,0]	[0.75, 0.5,0.25]	[0.75, 0.5,0.25]
$C_{3\ T, I, F}$	[0.5, 0.25,0]	[0.75, 0.5,0.25]	[0, 0,0]	[0.5, 0.25,0]
$C_{4\ T, I, F}$	[0.75, 0.5,0.25]	[0.5, 0.25,0]	[0.5, 0.25,0]	[0, 0,0]

From the behavior of the weights attributed to the alternatives and the development of the manifestations, the degree of belonging to a disease is determined through an aggregation process. Table 2 shows the result of the calculation performed.

Table 2: Weight attributed to the criteria.

Criteria	Weights of the nodes
C_1	0,1226
C_2	0,1515
C_3	0,1411
C_4	0,1351

This profile can be obtained in a direct way, beginning with the computing algorithms used to capture the institutions. Equation 4 describes the process of obtaining.

$$F_{a_j} = \{v_1^j, \dots, v_k^j, \dots v_l^j\}, j = 1, \dots n \tag{4}$$

The criteria of the institutions, a_i will be expressed using he linguistic scale S, $v_k^j \in S$ where:$S = \{s_1, \dots, s_g\}$, is a group of linguistic terms defined to evaluate the features C_k using the SVN numbers. For this, the linguistic terms to use, are defined. Equation 5 describes the process.

$$A = \{a_1, \dots, a_j, \dots, a_n\} \tag{5}$$

The profiles are saved in a database for the future recovering.

Activity 2. Evaluation and classification of alternatives:

In this activity is determined the information about institutions over the preference which are saved in the profile, such as:

$$P_e = \{p_1^e, \dots, p_k^e, \dots, p_l^e\} \tag{6}$$

The profile will be integrated by a group of attributes that caracterize the institutions:

$$C^e = \{c_1^e, \dots, c_k^e, \dots, c_l^e\} \tag{7}$$

Where:

$$c_k^e \in S \tag{8}$$

This one can be obtained by means of an example or the well- called conversational view and other examples that can be adapted.

Activity 3. Generation of recommendations:

In this activity, institutions are filtered according to the saved profile to find what or which are more appropriated according to the recent features.

With this purpose, it is calculated the similarity among institutions feature, P_e and each available profile aj registered in the database.

For calculating the whole similarities, it is used the following expression:

$$S_i = 1 - \left(\left(\frac{1}{3} \sum_{j=1}^{n} \left\{ \left(\left| a_{ij} - a_j^* \right| \right)^2 + \left(\left| b_{ij} - b_j^* \right| \right)^2 + \left(\left| c_{ij} - c_j^* \right| \right)^2 \right\} \right)^{\frac{1}{2}} \right) \quad (9)$$

The function S calculates the similarity among attributed values of the institutions profile and saved ones, ai.

Once, it is calculated the similarity among the institutions profile and saved ones in the database, each profile are organized according to the similarity obtained, representing by the following similarity vector.

$$D = (d_1, \dots, d_n) \quad (10)$$

The best recommendation will be ones that satisfy the needs of the institutions profile, that`s to say, which present more similarities.

4 Model implementation in a case study in UNIANDES, Ibarra

This section describes the implementation of the proposed method to evaluate cultural diffusion. For the application of the proposal, it is based on the set of data stored in the database on the behavior of the diffusion indicators of different institutions. The stored institutions have a set of patterns that are classified according to their level of diffusion. The classification on the stored data allows to determine the level of diffusion that the institutions possess.

A case study is applied in UNIANDES, Ibarra with the objective of determining the evaluation of cultural diffusion. Below is the demonstrative example used as a study house. It starts from the database it owns and executes the proposed method.

$$A = \{a_1, a_2, a_3, a_4, a_5\}5$$

Described by the group of attributes

$$C = \{c_1, c_2, c_3, c_{4,}, c_5\}$$

The attributes are valued in the following linguistic scale (table 3)

This valuation is saved to nurture the database.

Table 3. Linguistic terms used [24].

Linguistic terms	SVN number
(EB) Extremely good	(1,0,0)
(MMB) Excellent	(0.9, 0.1, 0.1)
(MB) Verygood	(0.8,0,15,0.20)
(B) Good	(0.70,0.25,0.30)
(MDB) So-so	(0.60,0.35,0.40)
(M) Media	(0.50,0.50,0.50)
(MDM) Awful	(0.40,0.65,0.60)
(MA) Bad	(0.30,0.75,0.70)
(MM) Very bad	(0.20,0.85,0.80)
(MMM) Very very bad	(0.10,0.90,0.90)
(EM)Extremely bad	(0,1,1)

The table 4 shows a view with the data used in the example.

Table 4. The database of the institutions profile.

	$\mathbf{c_1}$	$\mathbf{c_2}$	$\mathbf{c_3}$	$\mathbf{c_4}$
a_1	MMB	M	B	B
a_2	MB	B	MD	M
a_3	M	MMB	M	B
a_4	MB	B	MDB	B
a_5	MMB	MDB	M	B

If a institutions up wishes getting the recommendations of the system should provide information about his.

In Thais case:

$$P_e = \{\text{MB}, \text{B}, \text{MDB}, \text{M}\}$$

The following step in the example is calculating the similarity among the institutions profile and the saved ones in the database.

Table 5. Similarity among the institutions profile and saved profiles.

$\mathbf{a_1}$	$\mathbf{a_2}$	$\mathbf{a_3}$	$\mathbf{a_4}$	$\mathbf{a_5}$
0.28	0.65	0.26	0.75	0.25

In the recommendation`s phase will be suggested such profile that match more with the institutions profile. An organization of the profile based on the comparison will be the following one.

$$\{a_4, a_2, a_1, a_3, a_5\}$$

In the case that the system suggests two closest institutions, these ones will be the recommendations:

$$a_4, a_2$$

The performance of the recommendations will provide the closest result to the comparative profile for such example and it is:

$$a_4$$

Beginning with the demonstration made, it is seen the usefulness of the proposal.

Specifically, thea_4, institution is valued based on compliance with cultural dissemination indicators as an institution of high level of dissemination.

5. Conclusions

The present work developed a method for the evaluation of cultural diffusion. It based its operation on a multi-criteria approach with the use of neutrosophic numbers.

The proposed method is applied in a case study with the objective of assessing its applicability. The case was implemented in UNIANDES, Ibarra. It was obtained as a result from the fulfillment of the indicators of cultural diffusion as an institution of high level of diffusion.

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