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Competencies evaluation based on single valued neutrosophic numbers and decision analysis schema

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Abstract. Recently, neutrosophic sets and its application to decision making have become a topic of significant im-portance for researchers and practitioners. The present work addresses one of the most complex aspects of the formative process based on competencies: evaluation. In this paper, a new method for competencies evaluation is developed in a multicriteria framework. The proposed framework is composed of four activities, framework, gathering information, ideal solution distance calculation and ranking alternatives. Student are evaluated using SVN, for the treatment of neutralities, and Euclidean distance. The paper ends with conclusion and future work proposal for the application of neutrosophy to new areas of education.

Keywords: competency, evaluation, neutrosophy, SVN numbers

1 Introduction

In this paper, one of the most complex aspects of the formative process based on competencies is addressed: evaluation. A new method for competencies evaluation is developed in a multicriteria framework based on decision analysis.

Decision analysis is a discipline, belonging to decision theory, with the goal of computing an overall assessment that summarizes the information gathered and providing useful information about each evaluated element [1]. Uncertainty is present in real world decision making problems in such cases the use of linguistic information to model and manage such an uncertainty has given good results [2]. Experts feel more comfortable providing their knowledge by using terms close to human cognitive model [3, 4].

The conventional crisp techniques have been not much effective for solving decision problems because of imprecise or fuzziness nature of the linguistic assessments. It is more reasonable to consider the values of alternatives according as single valued neutrosophic sets (SVNS) [5]. SVNS can handle indeterminate and inconsistent information, while fuzzy sets and intuitionistic fuzzy sets cannot describe them [6]. In this paper a new model competencies evaluation is developed base on single valued neutrosophic number (SVN-number) allowing the use of linguistic variables [7] and giving methodological support based on decision analysis schema.

This paper is structured as follows: Section 2 reviews some important concepts about decision analysis framework and SVN numbers. In Section 3, is presented a decision analysis framework based on SVN numbers for competencies evaluation. Section 4 shows a case study. The paper ends with conclusions and further work recommendations.

2 Decision schemes

Decision analysis is a discipline with main purpose of helping decision maker to reach a consistent decision [8]. A common decision resolution scheme consists of following phases [2, 9].

- Identify decision and objectives.
- Identify alternatives.
- Framework:
- Gathering information.
- Rating alternatives.
- Choosing the alternative/s:
- Sensitive analysis
- Decide

In the framework phase, he structures and elements of the decision problem are defined: experts, criteria, etc. The information provided by experts is collected, according to the defined framework in the gathering information phase. In line with our aims in this paper, a SVN numbers [10] approach is developed due to the fact that provide adequate computational models to deal with linguistic information [11] in decision problems allowing to include handling of indeterminate and inconsistent .

A way to compute a rating of alternatives is to use an ideal alternative. A comparison between an ideal alternative and available options in order to find the optimal choice could be used [12]. Normally, the closer alternative to the ideal, corresponds to the best alternative.

3 SVN-numbers

Neutrosophy [13] is mathematical theory developed for dealing with indeterminacy . The truth value in neutrosophic set is as follows [14]:

Let N be a set defined as: $N = \{(T, I, F) : T, I, F \subseteq [0, 1]\}$, a neutrosophic valuation n is a mapping from the set of propositional formulas to N , that is for each sentence p we have $v(p) = (T, I, F)$.

To facilitate the real world applications of neutrosophic set and set-theoretic operators single valued neutrosophic set (SVNS) [5] was developed

A single valued neutrosophic set (SVNS) has been defined as follows [5]:

Let X be a universe of discourse. A single valued neutrosophic set A over X is an object having the form:

$$A = \{\langle x, uA(x), rA(x), vA(x)\rangle : x \in X\} \quad (1)$$

where $u_A(x): X \rightarrow [0,1]$, $r_A(x), : X \rightarrow [0,1]$ and $v_A(x): X \rightarrow [0,1]$ with $0 \leq u_A(x) + r_A(x) + v_A(x) :\leq 3$ for all $x \in X$. The intervals $u_A(x)$, $r_A(x)$ y $v_A(x)$ denote the truth- membership degree, the indeterminacy-membership degree and the falsity membership degree of x to A, respectively.

Single valued neutrosophic numbers (SVN number) is denoted by $A = (a,b,c)$, where $a,b,c \in [0,1]$ and $a+b+c \leq 3$.

Alternatives could be rated according Euclidean distance in SVN [15, 16].

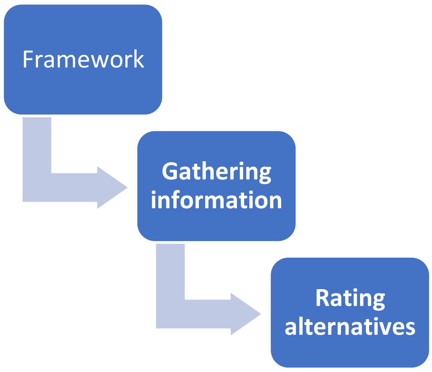
Let $A^* = (A_1^*, A_2^*, \ldots, A_n^*)$ be a vector of n SVN numbers such that $A_j^* = (a_j^*, b_j^*, c_j^*)$ j=(1,2, … , n) and $B_i = (B_{i1}, B_{i2}, \ldots, B_{im})$ $(i = 1,2, \ldots, m)$ be m vectors of n SVN numbers such that $B_{ij} = (a_{ij}, b_{ij}, c_{ij})$ $(i = 1,2, \ldots, m)$, $(j = 1,2, \ldots, n)$. Then the separation measure between $B_i's$ y A^* is defined as follows:

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

In this paper linguistic variables[11] are represented using single valued neutrosophic numbers [16] for developing a framework to decision support.

2.2 Proposed framework

Our aim is to develop a framework for competencies evaluation based on for decision analysis based and SVN numbers. The model consists of the following phases (graphically, Fig. 3).



The proposed framework is composed of three activities, framework, gathering information and rating alternatives.

Framework

In this phase, the evaluation framework, the decision problem structure is defined. The framework is established as follows:

C= $\{c_1, c_2, \ldots, c_l$ with $l \geq 2$, a set competencies.

E= $\{e_1, e_2, \ldots, e_k\}$ with $k \geq 2$ A set of students.

Gathering information

In this phase, the assessments is provided by means of assessment vectors:

$$U = (v_{ij}, i = 1, \ldots, l,\ j = 1, \ldots, k) \quad (3)$$

The assessment v_{ij}, for each criterion c_i of each student e_j, is expressed by means of SVN numbers.

Rating alternatives

For rating alternatives an ideal option is constructed [16, 17] .the evaluation criteria can be categorized into two categories, benefit and cost. Let C^+ be a collection of benefit criteria and C^- be a collection of cost criteria. The ideal alternative is defined as:

$$I = \left\{\left(max_{i=1}^{k} T_{U_j} | j \in C^+, min_{i=1}^{k} T_{U_j} | j \in C^-\right), \left(min_{i=1}^{k} I_{U_j} | j \in C^+, max_{i=1}^{k} I_{U_j} | j \in C^-\right), \left(min_{i=1}^{k} F_{U_j} | j \in C^+, max_{i=1}^{k} F_{U_j} | j \in C^-\right)\right\} = [v_1, v_2, \ldots, v_n] \quad (4)$$

Alternatives are rating according Euclidean distance to I (2). Ranking is based in the global distance to the ideal. If alternative x_i is closer to I the distance measure (s_i closer) better is the alternative [18].

3 Case study

A demonstrative example is given below. In the stage of establishing the evaluation framework, the domain in which the information will be verbalized is selected.
The following linguistic terms are used (Table 1).

Linguistic terms	SVNSs
Extremely good (EG)	(1,0,0)
Very very good (VVG)	(0.9, 0.1, 0.1)
Very good (VG)	(0.8,0,15,0.20)
Good (G)	(0.70,0.25,0.30)
Medium good (MG)	(0.60,0.35,0.40)
Medium (M)	(0.50,0.50,0.50)
Medium bad (MB)	(0.40,0.65,0.60)
Bad (B)	(0.30,0.75,0.70)
Very bad (VB)	(0.20,0.85,0.80)
Very very bad (VVB)	(0.10,0.90,0.90)
Extremely bad (EB)	(0,1,1)

Table 1. Linguistic terms used to provide the assessments [16].

Three core competencies are evaluated in three students.
c_1: Analyze, identify and define the requirements that must be met by a computer system to solve problems or achieve objectives of organizations and individuals.
c_2: Manage Databases through a Database Management System (DBMS).
c_3: Plan and manage software development projects.
Once the prioritization framework is established, the information is obtained.

	e_1	e_2	e_3
c_1	MDB	M	MMB
c_2	B	MMB	B
c_3	B	MDM	MB

Table 2: Preferences given by experts

From this information, the ideal alternative is calculated.
The ideal alternative results:
E^+ =(MMB, MMB, MB)
The results of the calculation of the distances allow us to order the students according to the achievement of the competences. In this case the priority order is the following: $e_3 \succ e_1 \succ e_2$

Student	**Distance**
e1	0.35355339
e2	0.59160798
e3	0.18484228

Table 3: Distance calculation

Among the advantages found by the specialists are the relative ease of the technique. The results also show the applicability of SVN-based decision support models to competency assessment.

Conclusions

In this paper, a competency assessment model was presented. The students were evaluated by means of the SVN numbers and the Euclidean distance for the treatment of neutrality.
Further works will concentrate extending the model for dealing with heterogeneous information [19] and a multi-expert setting . Another area of future work is the developing of new aggregation operators based on SVN numbers specially compensatory operators [20].

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