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An Application of Intuitionistic Fuzzy Sets in determining eligibility of a candidate for particular Job

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Abstract
In this paper, Sanchez's approach is studied and applied for finding the eligibility of various candidates for a number of posts. Some hypotheses and intuitionistic fuzzy set theory is used for finding the conclusions. It is worthy to note that the proposed work is not presented anywhere in the literature till date.
Keywords: *Fuzzy Set, Intuitionistic fuzzy set*

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I. INTRODUCTION

Fuzzy sets (FS) introduced by Zadeh [9] has showed meaningful applications in many fields of study. The idea of fuzzy set is welcome because it handles uncertainty and vagueness which Cantorian set could not address. In fuzzy set theory, the membership of an element is a single value between zero and one. Out of several generalizations of fuzzy set theory for various objectives, the notion introduced by Atanassov [1] in defining intuitionistic fuzzy sets (IFSs) is interesting and useful. Fuzzy sets are IFSs but the converse is not necessarily true [1]. In fact there are situations where IFS theory is more appropriate to deal with [5]. Besides, it has been cultured in [6] that vague sets [7] are nothing but IFSs. IFS theory has been applied in different areas, viz., logic programming [2, 3], decision making problems [8] etc. Many applications of IFS are carried out using distance measures approach. Distance measure between intuitionistic fuzzy sets is an important concept in fuzzy mathematics because of its wide applications in real world, such as pattern recognition, machine learning, decision making and market prediction, sale analysis, new product marketing, financial services, negotiation process, psychological investigations etc.

1.1 Basic Definitions

Here some basic definitions and preliminaries are given to help understand the intuitionistic fuzzy sets.

1.1.1 Fuzzy sets: Fuzzy sets are sets whose elements have degrees of membership. A fuzzy set is a pair (U,m) where U is a set and $m:U\rightarrow[0,1]$ a membership function. For each $x\epsilon U$ the value $m(x)$ is called the grade of membership of x in (U,m).

1.1.2 Intuitionistic fuzzy set: Let a set E be fixed. An intuitionistic fuzzy set or IFS A in E is an object having the form

$$A = \{\langle x, \mu_A(x), \nu_A(x)\rangle \mid x \in E\}$$

where the functions $\mu_A : E\rightarrow[0,1]$ and $\nu_A : E\rightarrow[0,1]$ define the degree of membership and the degree of non-membership respectively of the element $x\epsilon E$ to the set A, which is a subset of E, and for every $x\epsilon E$, $0 \le \mu_A(x) + \nu_A(x) \le 1$.

The amount $\Pi_A(x) = 1 - (\mu_A(x) + \nu_A(x))$ is called the hesitation part, which may cater to either membership value or non-membership value or both.

1.1.3 Intuitionistic Fuzzy Relation: Let X and Y be two non-empty sets. An intuitionistic fuzzy relation (IFR) R from X to$Y$ is an IFS of XxY characterized by the membership function μ_R and non-membership function ν_R. An IFR R from X to Y is denoted by $R(X\rightarrow Y)$.

1.1.4 Max-Min-Max Composition: If A is an IFS of X, max-min-max composition of the IFR $R(X\rightarrow Y)$ with A is an IFS B of Y denoted by $B=RoA$, and is defined by the membership function

$$\mu_{RoA}(y) = \vee_x [\mu_A(x) \wedge \mu_R(x, y)]$$

and the non-membership function

$$\nu_{RoA}(y) = \wedge_x [\nu_A(x) \vee \nu_R(x, y)]$$

$\forall y \in Y$ (where V=max, □=min).

1.1.5 Max-Min-Max Composition (between two relations): Let *Q(X→Y)* and *R(Y→Z)* be two IFRs. The max-min-max composition *RoQ* is the intuitionistic fuzzy relation from *X* to *Z*, defined by the membership function

$$\mu_{RoA}(x, z) = \vee_y [\mu_Q(x, y) \wedge \mu_R(y, z)]$$

and the non-membership function

$$\nu_{RoQ}(x, z) = \wedge_y [\nu_Q(x, y) \vee \nu_R(y, z)]$$

$\forall (x,z) \in XxZ$ and $\forall y \in Y$.

De et al [9] presented an application of intuitionistic fuzzy sets in medical diagnosis using three steps such as; determination of symptoms, formulation of medical knowledge based on intuitionistic fuzzy relations, and determination of diagnosis on the basis of composition of intuitionistic fuzzy relations. Atanassov [10, 11] carried out rigorous research based on the theory and applications of intuitionistic fuzzy sets (IFS). Ejegwa et al [9] reviewed the concept of IFS and proposed its application in career determination using normalized Euclidean distance method to measure the distance between each student and each career respectively. Solution is obtained by looking for the smallest distance between each student and each career. In this paper, Sanchez's approach is studied and applied for finding the eligibility of various candidates for a number of posts. Some hypotheses and intuitionistic fuzzy set theory is used for finding the conclusions. The organization of the paper is as follows. In Section II methodology of the proposed work is discussed with conclusion in Section III.

II. An Application of Intuitionistic Fuzzy Sets in determining eligibility of a candidate for particular Job

Methodology:

In this section, an application of intuitionistic fuzzy set theory in determining eligibility of candidates for particular Jobs is presented. In a given new startup company, suppose *C* is a set of Candidates who want to join, *Q* is the set of Qualifications a person is required to have in order to get that job and *P* is the set of Posts for which company has the vacancies.

We define intuitionistic fuzzy relation R from the set of Qualifications *Q* to the set of posts *P* (i.e., on *Q*x*P*) which reveals the degree of association and degree of non-association between Qualifications and Posts.

The methodology involves mainly the following two steps:

- Finding the composition between Candidates and Posts based on intuitionistic fuzzy relations.
- Determination of posts on the basis of composition of intuitionistic fuzzy relations.

Now let us observe this concept to a finite number of candidates. Let there be n candidates c_i , i=1,2,…,n, in a company. Thus $c_i \in C$. Let *R* be an IFR ($Q \rightarrow P$) and construct an IFR *M* from the set of candidates *C* to the set of Qualification *Q*. Clearly, the composition *T* of IFRs *R* and *M* (*T=MoR*) describes the state of candidates c_i in terms of the posts as an IFR from *C* to *P* given by the membership function

$$\mu_T(c_i, p) = \bigvee_{q \in Q} [\mu_M(c_i, q) \wedge \mu_R(q, p)]$$

and the non-membership function given by

$$\nu_T(c_i, p) = \bigvee_{q \in Q} [\nu_M(c_i, q) \wedge \nu_R(q, p)]$$

$\forall c_i \in C$ and $p \in P$.

For a given *R* and *M*, the relation *T=MoR* can be computed. From the knowledge f *M* and *T*, one may compute an improved version of the IFR *R* for which the following holds:

- $S_R = \mu_R - \nu_R \cdot \pi_R$ is greatest, and
- The equality *T=MoR* is retained.

An example is presented as follows to understand the methodology.

Let there be twelve candidates Patrick, Lyndon, Zack, David, Steph, Karry, Dan, Mark, Paul, Robin, Peter, Lauren in a new startup company for the vacancies available. Their Qualifications are divided into 5 categories each as follows:

Category 1*: B.Sc.+LINUX,*

Category 2*: B.Sc.+ Web Designing*

Category 3*: B.Sc.+ Management*

Category 4*: B.Sc.+ Technical*

Category 5*: B.Sc.+HTML.*

Let C = {Patrick, Lyndon, Zack, David, Steph, Karry, Dan, Mark, Paul, Robin, Peter, Lauren} be the set of candidates and Q= {Category 1, Category 2, Category 3, Category 4, Category 5} be the set of qualification.
The intuitionistic fuzzy relation $M\ (C\to Q)$ is given as in hypothetical Table 1.
Let the set of posts be P = {Team Leader, Designer, Project Manager, Technical Head, Developer}.
The intuitionistic fuzzy relation $R\ (Q\to P)$ is given as in hypothetical Table 2. Therefore the composition $T=MoR$ *and* S_R is as given in Table 3 and Table 4.

Table 1:

Q	Category 1	Category 2	Category 3	Category 4	Category 5
Patrick	(0.8,0.1)	(0.4,0.5)	(0.7,0)	(0.8,0.1)	(0.4,0.5)
Lyndon	(0.2,0.6)	(0.2,0.7)	(0.3,0.5)	(0.4,0.4)	(0.6,0.1)
Zack	(0.9,0)	(0.4,0.6)	(0.9,0.1)	(0.3,0.5)	(0.7,0)
David	(0.2,0.7)	(0,0.8)	(0.5,0.4)	(0.2,0.7)	(0.5,0.4)
Steph	(0.3,0.6)	(0,0.4)	(0.4,0.3)	(0.9,0)	(0.7,0.2)
Karry	(0.5,0.3)	(0.3,0.5)	(0,0.8)	(0.6,0.2)	(0.4,0.3)
Dan	(0.3,0.5)	(0.5,0.3)	(0.3,0.5)	(0.7,0.1)	(0,0.9)
Mark	(0.7,0.2)	(0,0.7)	(0.2,0.6)	(0.5,0.4)	(0.3,0.5)
Paul	(0.9,0)	(0.2,0.7)	(0.8,0)	(0.7,0.3)	(0,0.8)
Robin	(0.5,0.4)	(0.6,0.4)	(0.2,0.7)	(0.8,0.1)	(0.7,0.1)
Peter	(0.7,0)	(0.2,0.6)	(0,0.6)	(0.3,0.5)	(0.4,0.5)
Lauren	(0.6,0)	(0.5,0.3)	(0.7,0.2)	(0.8,0.1)	(0.3,0.7)

Table 2:

R	TEAM LEADER	DESIGNER	PROJECT MANAGER	TECHNICAL HEAD	DEVELOPER
Category 1	(0.8,0.1)	(0.2,0.7)	(0.3,0.5)	(0.8,0.1)	(0.8,0.1)
Category 2	(0.9,0)	(0.4,0.5)	(0.2,0.6)	(0.3,0.5)	(0.6,0.1)
Category 3	(0.4,0.5)	(0,0.8)	(0.8,0.1)	(0.2,0.7)	(0.3,0.5)
Category 4	(0.2,0.5)	(0.5,0.1)	(0.7,0)	(0.8,0)	(0.6,0.3)
Category 5	(0.5,0.3)	(0.9,0)	(0.6,0.1)	(0,0.8)	(0.7,0.2)

Table 3:

T=MoR	TEAM LEADER	DESIGNER	PROJECT MANAGER	TECHNICAL HEAD	DEVELOPER
Patrick	(0.8,0.1)	(0.5,0.1)	(0.7,0.1)	(0.8,0.1)	(0.8,0.1)
Lyndon	(0.5,0.3)	(0.6,0.1)	(0.6,0.1)	(0.4,0.4)	(0.6,0.2)
Zack	(0.8,0)	(0.7,0)	(0.8,0.1)	(0.8,0.1)	(0.8,0.1)
David	(0.5,0.4)	(0.5,0.4)	(0.5,0.4)	(0.2,0.7)	(0.5,0.4)
Steph	(0.5,0.3)	(0.7,0.1)	(0.7,0)	(0.8,0)	(0.7,0.2)
Karry	(0.5,0.3)	(0.5,0.2)	(0.6,0.2)	(0.6,0.2)	(0.6,0.3)
Dan	(0.5,0.3)	(0.5,0.1)	(0.7,0.1)	(0.7,0.1)	(0.6,0.3)
Mark	(0.7,0.2)	(0.5,0.4)	(0.5,0.4)	(0.7,0.2)	(0.7,0.2)
Paul	(0.8,0)	(0.5,0.3)	(0.8,0.1)	(0.8,0.1)	(0.8,0.1)
Robin	(0.6,0.3)	(0.7,0.1)	(0.7,0.1)	(0.8,0.1)	(0.7,0.2)
Peter	(0.7,0)	(0.4,0.5)	(0.4,0.5)	(0.7,0.1)	(0.7,0.1)
Lauren	(0.6,0)	(0.5,0.1)	(0.7,0.1)	(0.8,0.1)	(0.6,0.1)

Table 4:

S_R	TEAM LEADER	DESIGNER	PROJECT MANAGER	TECHNICAL HEAD	DEVELOPER
Patrick	0.79	0.46	0.68	0.79	0.79
Lyndon	0.44	0.57	0.57	0.32	0.56
Zack	0.8	0.7	0.79	0.79	0.79
David	0.46	0.46	0.46	0.13	0.46
Steph	0.44	0.68	0	0	0.68
Karry	0.44	0.44	0.56	0.56	0.57
Dan	0.44	0.46	0.68	0.68	0.57
Mark	0.44	0.44	0.56	0.56	0.68
Paul	0.44	0.46	0.68	0.68	0.79
Robin	0.57	0.68	0.68	0.79	0.68
Peter	0	0.46	0.46	0.68	0.68
Lauren	0	0.46	0.68	0.79	0.57

The conclusion drawn from Table 4 is shown below which gives the list of candidates and the posts for which they are eligible.

Candidates	Post for which they are eligible
Patrick	Technical Head/Team Leader/Developer
Lyndon	Designer/Project Manager
Zack	Project Manager/Technical Head/Developer
David	Team Leader/Designer/Project Manager/Developer

Steph	Designer/Developer
Karry	Developer
Dan	Project Manager/Technical Head
Mark	Team Leader/Technical Head/Developer
Paul	Project Manager/Technical Head/Developer
Robin	Technical Head
Peter	Technical Head/Developer
Lauren	Technical Head

III. CONCLUSION

In this dissertation, Sanchez's approach is studied and applied for finding the eligibility of various candidates for a number of posts. Here Table 1 and Table 2 values are taken hypothetically and used IFS theory for finding the conclusions. It is worthy to note that the proposed work is not presented anywhere in the literature till date.

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