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DECISION MAKING PROBLEM USING BIPOLAR INTUITIONISTIC FUZZY CORRELATION MEASURE

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Abstract

The idea of the paper is to investigate bipolar intuitionistic fuzzy correlation measure in bipolar intuitionistic fuzzy environment. We further make use of the derived bipolar intuitionistic fuzzy correlation measure in solving a real life situation relating to the first wave of COVID-19. The results are tabulated and observations are discussed.

1. Introduction

In The notion of fuzzy set was brought through Zadeh [29] in the year 1965 and later Atanassov [2, 3] generalised this notion to a new category of intuitionistic fuzzy sets by the usage of the notions of fuzzy sets. Bipolar valued fuzzy sets, which used to be delivered with the aid of Lee [18] in 2000, which is an extension of fuzzy sets whose membership degree range is enlarged from the interval [0,1] to [-1,1]. D. Ezhilmaran and K. Sankar [10] in the year 2015, mentioned at the morphism of bipolar intuitionistic fuzzy graphs and advanced its associated properties. Later bipolar intuitionistic fuzzy sets in a gentle surrounding was put ahead by means of Chiranjibe

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Jana and Madhumangal Pal [8] in the year 2018.

Correlation coefficient, an essential perception in statistics, quantifies the linear relationship among random variables. It is broadly utilized in statistical evaluation and engineering sciences. In consideration of crisp set theory which can't address the ambiguities and uncertainties, therefore, the concept of correlation coefficient has been prolonged to FS principle for higher results. Several authors [6, 7, 13, 20] explored the correlation among fuzzy membership functions. Correlation Analysis of IFS [11, 14, 15, 16, 28] performs a important function in current studies area. The correlation coefficient of IFS in phrases of statistical values, using imply aggregation functions became offered by Mitchell [19]. Based on geometrical illustration of IFSs and 3 parameters, a correlation coefficient of IFSs was described by Wenyi Zeng and Hongxing Li [25]. The correlation coefficient is an essential measure to decide the relation among objects. The correlation coefficients [3, 17, 21, 22, 24, 27] were broadly hired to record evaluation and classification, selection making, sample recognition, and so on. Wang and Li [23] brought the new correlation. Xu [26] advanced any other correlation measure of interval-valued intuitionistic fuzzy environment, and carried out it to clinical diagnosis. Bustince and Burillo [4] and Hong [12] similarly advanced the correlation coefficients for interval-valued intuitionistic fuzzy sets (IVIFSs).

In this paper we introduce bipolar intuitionistic fuzzy correlation measure. We further make use of the constructed bipolar intuitionistic fuzzy correlation measure for solving a decision making problem in real life situation.

2. Bipolar Intuitionistic Fuzzy Correlation Measure

Definition 2.1. Let $A = \{y_i, \mu_A^P(y_i), \mu_A^N(y_i), \nu_A^P(y_i), \nu_A^N(y_i) \mid y_i \in Y\}$ and $B = \{y_i, \mu_B^P(y_i), \mu_B^N(y_i), \nu_B^P(y_i), \nu_B^N(y_i) \mid y_i \in Y\}$ be any two BIFS in $Y = \{y_1, y_2, y_3, \ldots, y_n\}$. Then the bipolar intuitionistic fuzzy correlation similarity measure between the two BIFS A and B is given by

$$BIF_{CRSM}(A, B) = \sum_{i=1}^{n} (\mu_A^P(y_i)\mu_B^P(y_i) + \nu_A^P(y_i)\nu_B^P + (y_i)\mu_A^N(y_i)\mu_B^N(y_i)$$

$$+ \nu_A^N(y_i)\nu_B^N(y_i) + \pi_A^P(y_i)\pi_B^P(y_i) + \pi_A^N(y_i)\pi_B^N(y_i))$$

Definition 2.2. Let $A = \{y_i, \mu_A^P(y_i), \mu_A^N(y_i), \nu_A^P(y_i), \nu_A^N(y_i) \mid y_i \in Y\}$ and $B = \{y_i, \mu_B^P(y_i), \mu_B^N(y_i), \nu_B^P(y_i), \nu_B^N(y_i) \mid y_i \in Y\}$ be any two BIFS in $Y = \{y_1, y_2, y_3, \ldots, y_n\}$. Then the bipolar intuitionistic fuzzy correlation coefficient similarity measure between the two BIFS A and B is given by

$$BIF_{CRCSM}(A, B) = \frac{BIF_{CRSM}(A, B)}{\sqrt{BIF_{CRSM}(A, A) \times BIF_{CRSM}(B, B)}}$$

where

$$BIF_{CRSM}(A, B) = \sum_{i=1}^{n} (\mu_A^P(y_i)\mu_B^P(y_i) + \nu_A^P(y_i)\nu_B^P(y_i) + \mu_A^N(y_i)\mu_B^N(y_i)$$

$$+ \nu_A^N(y_i)\nu_B^N(y_i) + \pi_A^P(y_i)\pi_B^P(y_i) + \pi_A^N(y_i)\pi_B^N(y_i))$$

$$BIF_{CRSM}(A, A) = \sum_{i=1}^{n} ((\mu_A^P(y_i))^2 + (\nu_A^P(y_i))^2 + (\mu_A^N(y_i) + \nu_A^P(y_i))^2$$

$$+ (\pi_A^P(y_i))^2 + (\pi_A^N(y_i))^2)$$

$$BIF_{CRSM}(B, B) = \sum_{i=1}^{n} ((\mu_B^P(y_i))^2 + (\nu_B^P(y_i))^2 + (\mu_B^N(y_i) + \nu_B^N(y_i))^2$$

$$+ (\pi_B^P(y_i))^2 + (\pi_B^N(y_i))^2)$$

Proposition 2.3. *For any two BIFS A and B in* $Y = \{y_1, y_2, y_3, \ldots, y_n\}$. *the* BIF_{CRCSM} *should satisfy the following properties*:

1. $0 \leq BIF_{CRCSM}(A, B) \leq 1$.
2. $BIF_{CRCSM}(A, B) = 1 \Leftrightarrow A = B$.
3. $BIF_{CRCSM}(A, B) = BIF_{CRCSM}(B, A)$

3. Application of Bipolar Intuitionistic Fuzzy Correlation Measure in Decision Making Problem

Here, the proposed correlation measure point out whether the impact in family life and personal life is created by society, mass-media and government by the highest similarity measure. The unique feature of this proposed method is that it considers positive membership, negative membership and positive non- membership, negative non-membership. Let F_1 be family life and F_2 be personal life. Let $A = \{A_1, A_2, A_3, A_4, A_5\}$ be the set of different age groups and let $I = \{I_1, I_2, I_3\}$ be the set of impacts. Our solution is to examine which had a greater impact in personal life and family life during the first wave of Covid-19.

Algorithm 3.1

Step 1. The relationship between family life, personal life and age group is given in table 1.

Step 2. The relationship between age group and impact created by the society, government, mass media during the lockdown is given in table 2.

Step 3. We calculate the bipolar intuitionistic fuzzy correlation measure from table 1 and 2 and it is given in table 3.

Table 3.1. Relation between family life, personal life and age group.

Q	Less than 20	20-29	30-39	40-49	50 and above
Family life	{0.641,-0.261, 0.076,-0.027, 0.283,-0.712}	{0.638,-.246, 0.098,-0.022, 0.264,-0.736}	{0.602,-0.2295, 0.138,-0.031, 0.2603,-0.739}	{0.659,-0.227, 0.091,-0.028, 0.250,-0.750}	{0.438,-0.375, 0.188,0, 0.375,-0.625}
Personal life	{0.443,-0.322, 0.165,-0. 0695, 0.391,-0.609}	{0.488,-0.272, 0.164,-0.077, 0.349,-0.652}	{0.498,-0.216, 0.212,-0.045, 0.289,-0.739}	{0.527,-0.2991, 0.164,-0.018, 0.309,-0.683}	{0.45,-0.35,0.15, -0.05, 0.4,-0.6}

Table 3.2. Relation between age group and impact created by the society, government, mass media.

R	Society's impact	Government's impact	Mass-Media impact
Less than 20	{0.4673,-0.3152, 0.1521,-0.0652, 0.3806,-0.6196}	{0.4608,-0.4, 0.1043,-0.0347, 0.4349,-0.5653}	{0.6666,-0.2028, 0.1.14,-0.0289, 0.232,-0.7683}
20-29	{0.3511-0.4297, 0.1460,-0.0730, 0.5029,-0.4973}	{0.4179,-0.4089, 0.4179,-0.4089, 0.5057,-0.4945}	{0.4606,-0.3295, 0.4606,-0.0636, 0.3934,-0.6069}
30-39	{0.3367,-0.4030, 0.1632,-0.0969, 0.5001,-0.5001}	{0.3673,-0.4734, 0.0775,-0.0816, 0.5552,-0.445}	{0.4217,-0.3537, 0.1768,-0.0476, 0.4015,-0.5987}
40-49	{0.4318,-0.3181, 0.1590,-0.0909, 0.4092,-0.591}	{0.5090,-0.3090, 0.0909,-0.0909, 0.4001,-0.6001}	{0.2727,-0.4545, 0.2121,-0.0606, 0.5152,-0.4849}
50 and above	{0.5625,-0.4375, 0, 0, 0.4375, -0.5625}	{0.45,-0.55, 0, 0, 0.55,-0.45}	{0.5,-0.4166, 0.0833, 0, 0.4167,-0.5834}

Table 3.3. Bipolar intuitionistic fuzzy correlation measure

S	Society's impact	Government's impact	Mass-Media impact
Family life	0.9310	0.9207	0.9455
Personal life	0.9619	0.9458	0.9590

Observations.

1. From table 3.3 the decisions are based on the largest correlation

coefficient value in each row of the table between F_i's and I_i's

2. We can conclude that during the first wave of Covid-19, in family life the impact created by mass-media is more and in personal life the impact created by the society is more.

3. Higher the correlation coefficient value, higher the chances of the specified impact in personal and family life.

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