

PREFERENCE OF CUSTOMERS FOR ONLINE VIDEO STREAMING APPS IN AI THROUGH DISTANCE MEASURES IN GENERALIZED FUZZY THEORY

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Abstract

As digital media and other broadcasts continue to expand, the interest of customers is increasing towards online streaming services. The various online video apps are continuously changing the interest and behavior of customers. Videos, movies, music and some other types of media files are first arranged and then transmitted in sequential packets of data so they can be directly streamed. The word streaming refers to any media content recorded or live, delivered to mobile devices and computers through internet and played back in real time. The main objective of online video streaming is to acquire customers according to their needs and wants from business point of view. The adoption of online video apps by customers have presented here after keeping in mind the influencing factors. In this study we explore a number of factors which customers consider while choosing an online streaming option. The sample data was collected through a survey questionnaire filled by teen age students. The relation between customers and factors then between factors and some famous online video apps has shown. The word μ denotes for degree of membership, ν denotes as degree of non-membership and π indicates hesistant index. The final results are prepared by applying distance measures (Minkowski and Manhattan). An example has also given to illustrate these measures in generalized fuzzy set theory.

Keywords: IF sets, IF relations, Minkowski distance measure, Manhattan distance measure, online video streaming apps

Background

As we all know that artificial intelligence is being used in lots of fields these days. Artificial intelligence also works in the construction of a mathematical model according to the nature of the problem. A mathematical model in AI is a collection of various logical expressions that involves the relationship among different variables. The main aim of AI is to transform the situation into a real world situation by applying a mathematical model. While applying a mathematical model it should be keep in mind that model must be valid representative and capable of being solved the original situation. At last we can say that AI is the future of the society. It is doing something that once seemed unthinkable.

The concept of AI was first given by John McCarthy in 1955 in a conference. He presented an article entitled “computing machinery and intelligence”. He said AI is the science and engineering of making intelligent machines. The importance of AI is rapidly increasing. This system is mainly controlled by algorithms by using various methods such as deep learning and machine learning. This modern technology of AI has their own risk factors. So we should

use these machines and their coding very carefully. Sometimes these machines can be hacked the privacy of a person and even be used as a weapon. The complete AI system (either hypothetical or real) is of three types given as:

- (i) Weak AI
- (ii) Strong AI
- (iii) Artificial Super Intelligence (ASI)

Today's ASI is presenting a hypothetical situation as shown in movies, fiction books etc. where machines have taken over the world. Thus we can say that artificial systems can also be said advanced machine learning software with extended behavioral algorithms and codes which shelter themselves to our likes and dislikes.

There are a lot of examples of AI as siri, amazon.com, nest, tesla, pandora, cogito, boxever etc. But here in this article we have studied the interest of various customers about online video streaming apps in AI. There are so many types of online video streaming apps which are available in the market in different languages. Some of the apps are freely available and some of them are paid. Each of the video streaming app has its own terms and conditions, objectives and importance etc. The video streaming mainly refers to any live or recorded media content which is delivered to mobile devices and computers through internet and played back in real time. Podcasts, webcasts, TV shows, movies are some common forms of video streaming. In streaming the audio and video quality is usually in HD. The four basic things which are required while streaming are (a) camera (b) microphone (c) streaming software (d) good internet connection. Rondeau [18] used markov models and fuzzy logics in different techniques in cognitive radio. He introduced the concept of cognitive engine and also developed a flexible platform with different components which are sensors, optimizers, decision maker etc. Du [4] built a model to predict student's academic performance in college based on classification algorithm. Odili et. al. [13] applied the artificial intelligence concept in travelling salesman problem. Garrido [5] discussed the importance of artificial intelligence in mathematical education. Balacheff [2] raised some expectations on mathematical education and artificial intelligence then discussed with the help of some questions. Zhu [26] et. al. adopted a method using bayesian networks which represents the relationship between symptoms and crop diseases. Lingam [12] illustrated the machine learning process adopted by amazon, inventory models and the AI tools. Kumar et. al. [10] described correlation between artificial intelligence and soft computing in various areas. Soni and Puthawala [20] studied millennials preferences for online video streaming apps. Lee et. al. also [11] defined factors affecting online streaming subscriptions.

Applied Methodology

The validity of the above research depends on how precise the data is. The validity reduces when questionnaire contains linguistic variables and the respondent has to answer in one or zero. The vagueness in the mind of respondent can be minimized by getting a response in an intuitionistic fuzzy sense. The observational and analytical research has been followed to find the solution. The traditional way of conducting research in mathematical sciences, marketing, business, health services, and psychological research etc. is survey sampling. In these fields, normally the information is collected from a sample of individuals through their responses about certain questions. The survey sampling research is mainly categorized into

quantitative (using a questionnaire with numerically rated items), qualitative (using a questionnaire with binary, open-ended, closed-ended, and rating scale questions) and mixed research procedures (both numerically rated and rating scale questions). In the present study, we have proposed intuitionistic fuzzy aggregative investment benefit rate to select the best online video streaming app in artificial intelligence where respondents express both membership function and non-membership function for linguistic variables, with some hesitancy level, and give significant improvement over the intuitionistic fuzzy assessment method. A questionnaire was filled from some customers who frequently use online video streaming apps (about their liking and disliking). The paper addresses the problem of complex socio-economic phenomena assessment using questionnaire surveys. The obtained data was represented on an ordinal scale; the object assessments may contain positive, negative, no answers, a 'difficult to say' or 'no opinion' answers. The general framework for Intuitionistic Fuzzy set with relation to distance measures has been used to analyze the survey data for the ideal solution. The main aim of this study is to find out which online video streaming app is mostly used by customers. The study also explains the characteristics of these online video streaming apps. The whole study has been done in the form of cross tables (rows and columns). Firstly, we make a matrix which contains the IF relation between customers and features (influencing their choice for selecting the online video streaming app). The hesitant index table was also build. In the next step, we consider the IF relation between the features and important online video streaming apps. Again, the intuitionistic index table was made. In the last step (in third and fourth step) we apply Minkowski distance measure and Manhattan distance measure on the previous tables and get results. Finally, the comparison between the values of tables has studied. The minimum value from both the tables has been selected to obtain the solution. If we find there is any tie in the table values, then we say that those customers are interested in selecting both types of online video streaming apps.

Artificial Intelligence in IFS Theory

Most of the mathematical models in AI have practical applications, a fuzzy system and its generalization is one of them. The applications of AI are mainly depend upon a mathematical framework. A fuzzy logic is a system in which inputs may be crisp or fuzzy but the resulting output data must be fuzzy. So it is necessary to understand the fuzzy information system and its generalization in AI. Fuzzy modeling is mainly used to transfer the knowledge of a researcher into a mathematical model. Fuzzy logic in AI helps computers to deal with similar situations where input data is a bit unclear. For example if someone asks you whether you are available on a specific date next week or next month, then you probably would not say yes or no straight away. It is because you are not perfectly sure that you would not be busy on that very date next week or next month. So fuzzy or generalized fuzzy logic is applicable in those situations where we are unable to give clear answer (say yes or no). When the situation is not clear the computer is unable to say true or false as Boolean logic 1 or 0. The fuzzy logic algorithm considers all the uncertainties of a problem, where the possible values may be present besides true or false. These possible values can be:

(a) certainly yes (b) possibly yes (c) cannot say (d) possibly no (e) certainly no

We can define the above situation with the help of an example given below:

Problem – is it hot outside?

Boolean logic – solution

Yes (1.0)

No (0)

According to the classical Boolean logic, the algorithm will take a proper input and produce a precise result say no and yes. This output is represented by 0 and 1, respectively.

Fuzzy logic – solution

Very hot (0.9)

Moderately hot (0.38)

Little hot (0.20)

Not hot (0.0)

So, in the case where correct reasoning is not applicable, fuzzy logic provides an acceptable method of reasoning. While solving a problem an algorithm takes all the available data based on fuzzy logic. Then it takes the best possible decision according to the input. In the end we can say that generalized fuzzy logic in AI is a generalized form of standard logic, where the concept contains the truth degree ranging between 0.0 to 1.0. The modern application areas of fuzzy and generalized fuzzy logic are in factory controllers and industrial software's, home theatre and entertainment, digital camera and shopping sites etc. Rondeau [18] applied various techniques in cognitive radio. He also used mathematical models and fuzzy logics in AI. Varghese and McKee [24] proposed the swarm intelligence pattern mathematical transformation model. Balacheff [2] raised some expectations on AI and mathematical education with the help of some questions. Ramirez and Mayorga [17] discussed about fuzzy inference system and membership functions and did their applications in general fuzzy information system. Prince et. al. [15] derived some parametric entropies in intuitionistic fuzzy set theory and did their application in some decision-making problems.

Brief Introduction to Minkowski and Manhattan Distance Measures

Distance measures play an important role in artificial intelligence. Distance measures provide the foundation for many effective and popular machine learning algorithms. A distance measure is an objective score that summarizes the relative difference between two objectives. Generally the two objectives are rows of data that describe a subject or an event. When we calculate the distance between two rows or examples of data then it is possible that different data types may be used for different columns of the examples. An example might contain Boolean values, categorical values, likert scale values etc. Different distance measures are required for each that are summed together in a unique distance score. In this article we have applied two distance measures namely Minkowski and Manhattan distance measures.

- (a) Minkowski Distance Measure: This distance measure calculates the distance between two real-valued vectors. Minkowski distance is a generalization of Euclidean distance measure and Manhattan distance measure which adds a parameter called the order of p that allows different distance measures to be calculated. The main properties of Minkowski distance measure are (a) positivity (b) symmetry (c) triangular inequality.
- (b) Manhattan Distance Measure: Manhattan distance is the sum of absolute differences between points across all the dimensions. This distance measure is also known as city block distance. Manhattan distance is more useful to vectors that describe objects on a uniform grid like chessboard or city blocks. To calculate the integer feature space of two vectors Manh

attan distance is used. The Manhattam distance is mainly related to sum absolute error and mean absolute error metric.

Preliminaries

The origin of information theory was done in 1948 by C E Shannon [19]. The measure given by Shannon is also known as measure of uncertainty and probability. Similarly the origin of fuzzy theory was done in 1965 by Zadeh [25] and intuitionistic fuzzy theory was done in 1986 by K T Atanassov [1]. Both the theories are used in a vague and unclear situation. The main difference between the information theory and fuzzy theory is that the information theory deals with uncertainties while fuzzy theory deals with vagueness and ambiguous. The IF theory is also known as the generalization of fuzzy theory because of containing intuitionistic index. The values lies in the interval (0, 1) in both theories. Szmidt and Kacprzyk [22] have derived some new measures for intuitionistic fuzzy sets. Prince et. al. [14] have found the interest of customers about the selection of life insurance policies in IFS theory. Hung and Yang [6] also gave some fuzzy entropy functions in IFS theory. Now we study some basic definitions of fuzzy set theory and intuitionistic set theory to facilitate subsequent exposition.

Definition 1. Let X be any non-empty set $X = \{x_1, x_2, \dots, x_n\}$ be the universe of discourse. Then a fuzzy set A in X is defined as:

$$A = \{ \langle x, \mu_A(x) \rangle \mid x \in X \} \text{ Where } \mu_A(x) : X \rightarrow [0,1] \text{ is the membership degree.}$$

Definition 2. Let $X = \{x_1, x_2, x_3, \dots, x_n\}$ be a universal set. Then an IF set A in X given by Atanassov can be defined as:

$A = \{ \langle x, \mu_A(x), \nu_A(x) \rangle \mid x \in X \}$ Where $\mu_A(x) : X \rightarrow [0,1]$ and $\nu_A(x) : X \rightarrow [0,1]$ are membership and non-membership degree functions under the condition

$$0 \leq \mu_A(x) + \nu_A(x) \leq 1$$

The intuitionistic margin of IF set A defined in X is denoted by $\pi_A(x)$ and its value is calculated by applying the following expression:

$$\pi_A(x) = 1 - \mu_A(x) - \nu_A(x)$$

we can get $\pi_A(x) \in [0,1]$ for each $x \in X$. $\pi_A(x)$ is also called the intuitionistic index of x to A . If the value of $\pi_A(x)$ is more it indicates more vagueness. Obviously, when $\pi_A(x) = 0$ for all $x \in X$, then IFS degenerates into an ordinary fuzzy set. Generally, the couple $[\mu_A(x), \nu_A(x)]$ is also called an intuitionistic fuzzy value (IFV) for clarity.

Mathematical Definition of Distance Measures in IF theory

Definition 3: Let X be a non-empty set. Such that IFS $A, B, C \in X$. Then the distance measure d between IFS A and B is a mapping $d: X * X \rightarrow [0,1]$;

If $d(A,B)$ satisfies the following axioms

- $A_1: 0 \leq d(A, B) \leq 1$
- $A_2: d(A, B) = 0 \Leftrightarrow A = B$
- $A_3: d(A, B) = d(B, A)$
- $A_4: d(A, C) + d(B, C) \geq d(A, B)$
- $A_5: \text{if } A \subseteq B \subseteq C$

Then $d(A, C) \geq d(A, B)$ and $d(A, C) \geq d(B, C)$.

Now we define the distance measures (Minkowski and Manhattan) which are proposed here.

Let $A = \{ \langle x, \mu_A(x_i), \nu_A(x_i), \pi_A(x_i) \rangle : x \in X \}$

and

$$B = \{ \langle x, \mu_B(x_i), \nu_B(x_i), \pi_B(x_i) \rangle : x \in X \}$$

Be two IF sets in $X = \{x_1, x_2, x_3, x_4, \dots, x_n\}, i = 1, 2, 3, 4, \dots, n$ based on the geometric interpretation of IFS theory.

1. Minkowski Distance Measure

$$\left\{ \frac{1}{2} [(\mu_A(x_i) - \mu_B(x_i))^4 + (\nu_A(x_i) - \nu_B(x_i))^4 + (\pi_A(x_i) - \pi_B(x_i))^4] \right\}^{1/4}$$

2. Manhattan Distance Measure

$$\frac{1}{2} [|\mu_A(x_i) - \mu_B(x_i)| + |\nu_A(x_i) - \nu_B(x_i)| + |\pi_A(x_i) - \pi_B(x_i)|]$$

Husain et. al. [7] applied IFS theory in some decision making problems. Chen et. al. [3] derived some distance and similarity measures for intuitionistic hesitant fuzzy sets and did their application in various disciplines. Rajeshwari and Uma [16] did a study on intuitionistic fuzzy multi sets by applying normalized geometric and normalized hamming distance measures. Tugrul et. al. [23] applied normalized Euclidean distance measure in intuitionistic fuzzy environment. Recently, Kozae et. al. [9] used distance measures in intuitionistic fuzzy set theory to detect Corona patients.

Applied Technique

In the present section we study the situation related to the selection of online video streaming apps by some groups of customers. To get the solution we keep in mind all the features related to these online video streaming apps. Today's we see that there are so many video apps are available in the market according to their features. Some of them are more popular in comparison of other apps. In this study we consider customers in four groups, some famous online video apps and the important features related to these apps. Questionnaire was filled by group of customers. And the data was collected according to the Likert Scale in the range (0 to 0.1). At last the questionnaire has also shared. Here we have proposed Minkowski and Manhattan distance measures in IFS theory.

Let $C = [c_1, c_2, c_3, c_4]$ be the different groups of customers. Then $F = [f_1, f_2, f_3, f_4, f_5]$ = [security and privacy, video content management, price and quality, convenience and compatibility, user friendly interface] be some features which influence the interest customers for the selection of an online video streaming app. In the last, $A = [a_1, a_2, a_3, a_4, a_5]$ = [Disney+Hotstar, Netflix, Amazon prime videos, Youtube, Voot] are some famous online streaming apps respectively.

Then the fuzzy relations Q and R are given as:

$$Q = \{ \langle (c, f), u_Q(c, f), \nu_Q(c, f) \rangle \mid (c, f) \in C \times F \}$$

$$R = \{ \langle (f, a), u_R(f, a), \nu_R(f, a) \rangle \mid (f, a) \in F \times A \},$$

Where $u_Q(c, f)$ indicates the interest of group of customers 'c' with the feature 'f'. The value $\nu_Q(c, f)$ means the interest of the group of customers 'c' is not characterized with the feature 'f'. And $u_R(f, a)$ defines degree to which the feature 'f' favors the selection of online video app 'a'. Similarly $\nu_R(f, a)$ represents the degree in which the feature 'f' does not confirm the selection of online video app 'a'.

Now we follow the procedure about the selection of online video streaming app by using the information taken from the chart of case study. This information will play a major role in the complete analysis when various types of online video streaming apps are present for the groups of customers.

Let $C = [c_1, c_2, c_3, c_4]$ be the various groups of customers. And $F = [f_1, f_2, f_3, f_4, f_5]$ be the set of some features related to online video streaming apps.

Let the IFS theory relations $Q (C \rightarrow F)$ is considered as:

Q	F ₁	F ₂	F ₃	F ₄	F ₅
Students	(μ_Q, ν_Q)	(μ_Q, ν_Q)	(μ_Q, ν_Q)	(μ_Q, ν_Q)	(μ_Q, ν_Q)
C ₁	(0.8,0.1)	(0.6,0.1)	(0.2,0.8)	(0.6,0.1)	(0.1,0.6)
C ₂	(0.0,0.8)	(0.4,0.4)	(0.6,0.1)	(0.1,0.7)	(0.1,0.8)
C ₃	(0.8,0.1)	(0.8,0.1)	(0.0,0.6)	(0.2,0.7)	(0.0,0.5)
C ₄	(0.6,0.1)	(0.5,0.4)	(0.3,0.4)	(0.7,0.2)	(0.3,0.4)

Table – I (membership values, non-membership values and intuitionistic index data related to various features)

The values of hesitant index (π) of above table are given in the following table.

Q	F ₁	F ₂	F ₃	F ₄	F ₅
C ₁	0.1	0.3	0.0	0.3	0.3
C ₂	0.2	0.2	0.3	0.2	0.1
C ₃	0.1	0.1	0.4	0.1	0.5
C ₄	0.3	0.1	0.3	0.1	0.3

Table – II (hesitant index values of the above table)

Again, $A = [a_1, a_2, a_3, a_4, a_5]$ be some online video streaming apps available according to their features. The group of customers may choose one or more than one app according to their interest.

Secondly, the intuitionistic fuzzy theory relation $R (F \rightarrow A)$ is taken as:

Q	A ₁	A ₂	A ₃	A ₄	A ₅
Factors	(μ_Q, ν_Q)	(μ_Q, ν_Q)	(μ_Q, ν_Q)	(μ_Q, ν_Q)	(μ_Q, ν_Q)
F ₁	(0.4,0.0)	(0.7,0.0)	(0.3,0.3)	(0.1,0.7)	(0.1,0.8)
F ₂	(0.3,0.5)	(0.2,0.6)	(0.6,0.1)	(0.2,0.4)	(0.0,0.8)
F ₃	(0.1,0.7)	(0.0,0.9)	(0.2,0.7)	(0.8,0.0)	(0.2,0.8)
F ₄	(0.4,0.3)	(0.7,0.0)	(0.2,0.6)	(0.2,0.7)	(0.2,0.8)
F ₅	(0.1,0.7)	(0.1,0.8)	(0.1,0.9)	(0.2,0.7)	(0.8,0.1)

Table – III (membership values, non-membership values and intuitionistic index values related to types of online video streaming apps)

Again, the values of hesitant index (π) of the above table are mentioned in the table.

Q	F ₁	F ₂	F ₃	F ₄	F ₅
S ₁	0.6	0.3	0.4	0.2	0.1
S ₂	0.2	0.2	0.3	0.4	0.2
S ₃	0.2	0.1	0.1	0.2	0.0

S ₄	0.3	0.3	0.2	0.1	0.0
S ₅	0.2	0.1	0.0	0.1	0.1

Table – IV (hesitant index values of the above table)

Now by applying Minkowski distance formula between two intuitionistic fuzzy sets the following result is obtained:

Minkowski Distance	Disney+ Hotstar	Netflix	Amazon Prime Videos	Youtube	Voot
C ₁	0.56	0.47	0.55	0.86	0.92
C ₂	0.77	0.94	0.59	0.23	0.80
C ₃	0.57	0.72	0.54	0.86	0.95
C ₄	0.38	0.49	0.56	0.67	0.77

Table – V (group of customers with respect to online video streaming apps)

Then we apply Manhattan distance between these two intuitionistic fuzzy sets. The results are as follows:

Manhattan Distance	Disney+ Hotstar	Netflix	Amazon Prime Videos	Youtube	Voot
C ₁	1.45	1.2	1.4	2.7	2.8
C ₂	2.0	2.5	1.6	0.7	2.1
C ₃	1.95	2.2	1.6	2.5	2.8
C ₄	1.45	1.50	1.9	2.2	2.7

Table – VI (group of customers in relation with online video streaming apps)

Here the above two tables are the final result of the research. So, the findings are the group of customers C₁ is interested to see movies or videos through Netflix. The group C₂ chooses youtube app. And the group of customers C₃ and C₄ are familiar with amazon prime videos and Disney+hotstar. Also, we get the similar result in both the tables (obtained from minkowski and manhattan distance measures).

Discussion and Conclusion

Artificial Intelligence is the most popular area of fuzzy theory and its generalization. Most of the modern technology used in home theatre and entertainment, air conditioning and heating, digital camera and TV etc. based on fuzzy logic. The fuzzy logic system is like a two way street. This system makes intelligent decisions and in the same time it takes responses of customers in fuzziness. So, in order to make the system more accurate and efficient, researchers apply fuzzy or intuitionistic fuzzy science on such devices. In this paper, groups of customers were selected randomly to find the final result. The applied technique can also be extended for larger groups of customers. The choices of the customers may be vary according to the

conditions and influencing features. So this type of application of intuitionistic fuzzy set theory is more beneficial.

The idea of intuitionistic fuzzy sets is of immense significance in applied mathematics based on decisions. In intuitionistic fuzzy set theory the output of a control loop is not fixed at a specific value. It varies within a specific range. This gives better control in comparison of fixed point control, especially in applications with a non-linear relationship between input and output. The IFS theory captures all the possibilities involve in various disciplines. The distance methods are more suitable in order to achieve more sensible results in these situations.

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Questionnaire

The students have to give number according to the Likert Scale measurement tool given below:

Part I

1. Do your parents are worried about your education?
2. Are your parents are educated (minimum graduate)?
3. Do your parents like classroom teaching in comparison of online learning?

Part II

1. Do you think this new technology is confused?
2. Do you feel stress while taking online classes?
3. Do you feel online learning requires more time for problem solving?

Part III

1. Are you comfortable while using these online apps?
2. Do your teachers and classmates help you to use these apps?
3. Are you satisfied with this online learning?

Part IV

1. Do your teachers and parents encourage you for online learning?
2. Do you think that the online learning is the demand of present society?
3. Does government encourage online teaching/learning?

Part V

1. Do your parents give you recharge facility for online classes regularly?
2. Do your parents have provided you and android mobile phone or laptop or notepad separately for online learning?
3. Do your parents allow you to for any part time job in addition to online learning?