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# A fuzzy trust measurement method considering patients' trust opinions in Internet plus Healthcare

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**Abstract**

With the outbreak of COVID-19, Internet plus Healthcare has developed rapidly with a number of Internet plus Healthcare platforms emerging. The problem of doctor-patient trust is a key issue restricting the development of the Internet plus Healthcare, which has aroused extensive attention of scholars. The patient's perceived trust on the Internet plus Healthcare platform has the characteristics of subjectivity, ambiguity, and high perceived risk. Therefore, existing trust calculation method becomes inapplicable because these characteristics have not been considered. In order to solve this problem, this study extracts influencing factors of patient trust on the Internet plus Healthcare platform, gives a trust calculation method based on intuitionistic fuzzy set theory, and added a risk preference coefficient in order to integrate the characteristics of patients' high perceived risk into the proposed method. This method is conducive to the platform to provide patients with more accurate doctor recommendations



*Keywords:* Internet plus Healthcare;perceived trust; risk preference;fuzzy intuition set

## 1. Introduction

Internet plus Healthcare is a new type of medical service model, which is deeply integrated with mobile communication technology, cloud computing, the Internet of Things, big data and other information technologies[1]. Internet plus Healthcare develops rapidly. It has online consultation, online appointment, health monitoring and other functions. And Internet plus Healthcare has played a great role to solve the difficulty of seeing a doctor, uneven distribution of medical resources and other issues in the epidemic period. Despite the rapid development of Internet plus Healthcare, its use rate is very low[2, 3, 4]. Patients usually register on the platform, and there are still many functions that are not used. But these functions are important to solve the imbalance in the allocation of medical resources. Akter has found[5] that trust has an important impact on patients' use of Internet-based healthcare service through research. For patients, medical treatment is a high-risk decision-making service, and the severity of

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the consequences of misdiagnosis and the inability to talk face-to-face between online medical patients and doctors are difficult to take. At the same time, for the same doctor, patients with different perceived risk preferences will have different perceived trusts. Therefore, how to quickly establish the perceived trust of each patient for online medical services is a problem that the Internet plus Healthcare service urgently needs to solve. The platform predicts the perceived trust of the patient based on the characteristics of the patient, so as to personalize the recommendation of the doctor based on reliability. This is an effective way to solve the above problems. To sum up, this is essentially a trust measurement problem. But the traditional trust measurement method is not applicable because it can not reflect the characteristics of patient subjectivity and ambiguity. Based on the doctor information provided by the platform, this paper will combine multi-attribute decision-making with intuitive fuzzy set to construct a patient trust measurement model. And to explore the differences in decision-making between patients with different risk preferences, we add a risk preference coefficient. In this way, we could transform patients' subjective perceived trust from seeing objective doctor information, and promote the rapid development of Internet plus Healthcare.

## 2. Literature review

### *2.1 Internet plus Healthcare doctor-patient trust research*

Trust is an important foundation for the establishment and maintenance of interpersonal relationships, and the doctor-patient relationship is one of many social relationships. Trust plays a particularly important role in it. Doctor-patient trust refers to the contractual relationship established between doctors and patients in the process of interaction[6]. This contractual relationship refers to the fact that the patient trusts the doctor, so the life are relied on the doctor, and the doctor carries the trust of the patient and is responsible for the patient's life. Therefore, the relationship of trust is inherently mutual, and the general study of the subject of trust involves both the patient and the provider of healthcare. Mccartney M. believes that trust is a two-way street, and we need doctors to be trustworthy, as well as patients who need to trust the doctor-patient relationship[7].

The current research on doctor-patient trust includes three aspects, which are trust dimension, trust influencing factors and trust results.

The purpose of exploring the dimension of doctor-patient trust is to explore the essential attributes of doctor-patient trust. Gray proposed a trust dimension framework for doctors or doctor groups' technical capabilities and trust ethics[8]. Mechanical reinterprets the dimension of trust from five aspects, which are technical ability, attention to patient welfare, control over medical decision-making, protection of patient privacy and attitude towards providing and receiving information[9]. Anderson and Dedrick proposed the trust in physician scale (TPS), which includes reliability, confidence (confidence in doctors' knowledge and ability), information (confidentiality and reliability of information provided by doctors)[10]. Thom et al. revised the TPS. The revised scale includes six aspects,which are loyalty, ability, honesty, confidentiality, behavior and overall trust[11].

The influencing factors of doctor-patient trust are usually divided into three categories,including patient factor, medical service provider factor and environmental factor. Patient side factors generally involve the patient's personal characteristics. Boulware et al. Have shown that trust patterns vary with race[12]. Simonds et al. Have found that cultural identity will affect the patient's trust in doctors[13].The factors of medical service providers mainly involve doctors. Research by Hamelin et al. reveals that doctors' medical level, oral communication skills and compliance with patient autonomy all have a significant impact on doctor-patient trust[14].The survey results of patients by omme and others reveal that information support, emotional support, joint decision-making and other factors will affect the trust level of patients in doctors[15]. Environmental factors mainly involve the system and the interaction environment between doctors and patients. Faja and likcani's research confirmed that the third-party trust mechanism and various communication channels will have a significant impact on the patient trust in the medical website[16]. At the same time, confidentiality, information provision and communication in the process of doctor-patient interaction will also affect patients' trust in doctors[17].

Patients' trust in doctors can affect patients' perception of medical services, reduce patients' anxiety[18] during treatment, help to reduce Doctor-patient Conflict and improve patients' satisfaction[19]. At the same time, it will also affect the behavior of patients. The level of patient trust has a positive impact on the duration of the doctor-patient relationship, the willingness of patients to recommend personal doctors to others, and the behavior of changing

personal doctors[19]. Doctor-patient trust also has an impact on patients' health outcomes, which can be divided into quality of life and clinical treatment effect. The research results of Lee et al. reveal that patient trust can affect patients' compliance with medical orders through self expectation efficacy and expectation of results, which is conducive to patients' personal health management[20].

Compared with traditional offline medical service, Internet plus Healthcare can not communicate with doctors face-to-face and is unfamiliar with the online treatment process, which brings great challenges to doctor-patient trust. Kim, Sbaffi, rowley found that individual patient characteristics and website-related factors have a significant impact on physician-patient trust building[21, 22]. Peng found that the perceived usefulness of patients' perception of online medical information and physician services could promote doctor-patient interaction and thus enhance doctor-patient trust[23]. In addition, because of a high-risk decision-making service provided by Internet plus Healthcare, the seriousness of the consequences of misdiagnosis leads to patients using Internet medical treatment to perceive a great risk, which in turn affects the establishment of their perceived trust. An empirical analysis of 3 health sites by BANSAL et al.[24] revealed that risk had a negative impact on trust in the site. MUN's research on online health information has also validated a significant negative impact of perceived risk on trust[25]. When the level of the patient's perceived risk is high, the patient develops a feeling of distrust of online medical health service. When the level of the patient's perceived risk is low, the sense of trust is higher.

### *2.2 Trust calculation*

Trust calculation refers to the assessment of confidence levels obtained through self-observation or reputational feedback from other objects. At present, the main algorithms and methods commonly used to evaluate trust are Bayesian inference[26], fuzzy logic[27, 28], and particle swarms[29]. But traditional trust calculation methods based on deduction, such as tidaltrust[30], moletrust[31], opinionwalk[32] and tison[33]. They need to make assumptions based on cognitive experience when studying the process of trust transmission and aggregation. And they are difficult to apply to different social networks. The assumptions need to be adjusted according to the situation of social networks. Therefore, the deductive method is not conducive to the deep understanding of trust transmission and aggregation, and will affect the accuracy of the algorithm.

At present, research on trust calculation is mainly focused on the P2P field, such as Kamvar proposing the EigenRep trust model[34] and Jennifer et al. proposed using FOAF to calculate the trust relationship between no direct users in web-based social networks[35]. Wang et al.[36] found that sellers with transaction risk are predicted based on their transaction history in e-commerce. They use two metrics in social networks, K-core and center weights, but this approach must require the presence of transaction records and is not suitable for calculating trust between ordinary users.

The above trust calculation methods are based on the author's experience and understanding of interpersonal relationship trust, basically from a certain perspective of technology to consider the trust problem.They are lack of sociological and psychological theoretical basis. Different from the previous reliability calculation, patients in the field of Internet plus Healthcare have the characteristics of subjectivity and ambiguity. And the trust of patients is three-dimensional, which is patients have both trust, distrust and uncertainty for doctors. Intuitionistic fuzzy sets are developed on the basis of fuzzy theory. Compared with fuzzy theory, intuitionistic fuzzy sets add two dimensions of hesitation and non membership on the basis of membership. They are suitable for solving decision-making problems with ambiguous information. At present, they also have some applications in the field of e-commerce research. Ruxialiang, jianqiangwang and other scholars attribute the evaluation of e-commerce websites to complex multi-attribute decision-making problems. They use the information collection module to collect the evaluation information provided by experts. And they use the single value trapezoidal set to integrate expert opinions to build a multi-attribute decision-making model to evaluate B2C e-commerce websites. Yangliu, jianwubi and other scholars[37] used emotion analysis technology to distinguish optimistic, neutral and negative comments of online comments. And they combined with intuitionistic fuzzy sets to score goods, so as to provide support for consumers' purchase decisions. To sum up, intuitionistic fuzzy sets can express perceived hesitation and uncertainty, and are very suitable to describe the perceived trust of patients in the field of Internet plus Healthcare, so this paper intends to use the intuitionistic fuzzy set theory to calculate the patient's trust level for the doctor.

### *2.3 Summary*

The bottleneck restricting the development of Internet plus Healthcare services is how to measure each patient's perceived trust in online medical service. At the same time, there are few studies on computing patients' perceived trust in online medical services now. But the subjectivity, ambiguity, multifactoriality and high risk of patient perception trust bring about the difficulty of perceptual trust conversion. And the traditional trust calculation method becomes inapplicable bcecause it can not reflect the above characteristics. So this paper considers the influencing factors of patients' perceived trust based on doctor attribute information. Combining multi-attribute decision-making with intuitionistic fuzzy sets to construct a patient trust measurement model and add a perceived risk preference coefficient to calculate the patient's perceived trust level.

## 3. Methodology

In this section, we firstly analyzed the patients' influence factors of perceived trust in the Internet plus Healthcare platform. Secondly, we use membership and non-membership of intuitionistic fuzzy sets to express the degree of trust and distrust of patients to doctors, and then we build the patient trust intuitionistic fuzzy sets, which is obtained by weighted rally and attributes sorting after patient trust scores. Finally, in order to take into account the characteristics of high-risk decision-making on Internet plus Healthcare platform, we added perceived risk coefficient $\lambda$ to obtain the perceived trust score of patients through calculation.

### *3.1 The key influencing factors of patients' perceived trust*

In the process of perceived trust establishment, the establishment of perceived trust of patients is mainly influenced by doctors, other patients and medical platforms[38]. Different from offline treatment, when patients choose doctors on the Internet plus medical platform, the perceived trust is mainly affected by the doctor information provided by the platform. As shown in Figure 1, where the text box information with white background is an important factor affecting the perceived trust of patients, and the text box information with light background has little impact on the perceived trust of patients, as follows:

a. Hospital grade

In China, hospitals are divided into grade I, II and III according to the hospital scale, scientific research direction, talents and technical force, medical hardware equipment, etc. And each grade is divided into grade A, grade B, and grade C. The higher the grade is, the higher the medical level is. Therefore, patients tend to trust hospitals with higher medical standards when choosing doctors[39].

b. The doctor's field of expertise

Doctors are distributed in various departments according to different types of the disease, and doctors in each department are good at their own disease areas. When patients choose a doctor, the more matched the disease is with the doctor's field, the higher the patient's trust in the doctor will be[40].

c. Doctor's title

The professional title of doctors in China generally has four levels, namely resident physician, attending physician, associate chief physician and chief physician. The professional title is positively correlated with the ability of doctors. The higher the professional title, the higher the professional level of doctors[40].

d. Comprehensive recommended popularity

The comprehensive recommendation popularity of doctors is generated by the online healthcare based on the number of patients' voting recommendations and other factors. The higher the popularity, the more patients are satisfied with the treatment effect of the doctor, and then vote to recommend the doctor. Therefore, when choosing a doctor, patients will naturally have more trust in the doctor with a higher degree of comprehensive recommendation[41].

e. Perceived quality of service

When patients feedback doctors' services, expressing satisfaction will give doctors a good comment, while expressing dissatisfaction will leave a bad comment and influence other patients to choose a doctor. Patient-generated evaluation content is an important indicator for patients to choose a doctor. The dissemination of good

evaluation content among patients will bring more patients and more influence to doctors. Therefore, patients' perception of service quality will affect their choice of doctor[10].

f. perceived risk preference

In online medical treatment, patients have perceived risks for online medical treatment[41].Due to the differences in educational level, social status, preference and other factors of each patient, different patients will make different decisions based on their own risk attitudes towards doctors.

g. Doctor's Reputation

The "Good Doctor of the Year" is a comprehensive calculation of the most recognized "good doctor" among tens of millions of patients based on their actual medical experience. When it comes to patients' choice of doctors, doctors with better reputations are more likely to be trusted by patients.

h. Online consultation experience

Online consultation experience refers to patients' perception of doctors' past diagnosis records. Generally speaking, the more records of past diagnosis, the more detailed doctors' responses, and the more trust patients have in doctors.

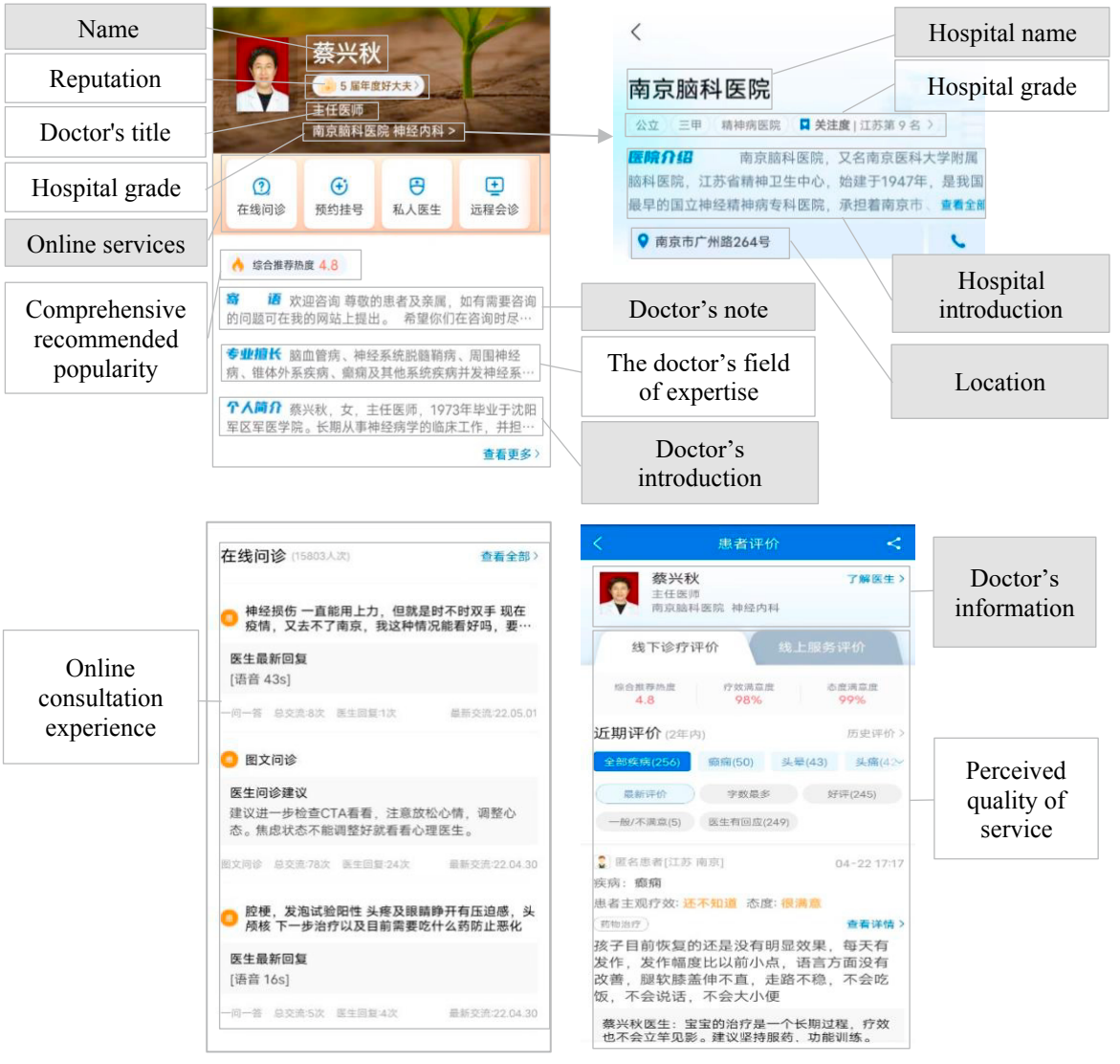

Fig.1. Factors influencing patients' perceived trust

### *3.2Intuitive fuzzy set theory*

Patient trust is characterized by fuzziness and uncertainty, which is the essential difference between patient-oriented Internet plus medical treatment and computer network with computer nodes as the main body. Intuitionistic fuzzy sets add the dimension of hesitation on the basis of the membership degree and non-membership degree of fuzzy theory, which can reflect the fuzziness of human perception and better reflect the characteristics of uncertainty of trust.

Let the patient's perceived trust be represented by intuitive fuzzy set $O=\langle \beta, \eta \rangle$, such that $\beta \in \lfloor 0, 1 \rfloor, \eta \in \lfloor 0, 1 \rfloor$ and satisfy the condition $\beta + \eta \in [0, 1], \pi = 1 - \beta - \eta$. Then $\beta$ and $\eta$ are the degree of membership and non-membership of O. The intuitionistic fuzzy set calculation formula used in this paper is as follows:

$$\lambda O = \langle 1 - (1 - \beta)^{\lambda}, \ \eta^{\lambda} \rangle$$
$$\varphi = \beta - \eta$$

### *3.3Transformation of patient trust intuition fuzzy sets*

Let the set of patients' perception of doctors' influence attribute be D={DA, DB, DC, DD, DE, DF, DG}. Among them, DA represents the hospital grade, DB represents the doctor's field of expertise, DC represents the doctor's title, DD represents comprehensive recommended popularity, DE represents online consultation experience, DF represents doctor's reputation and DG represents perceived quality of service. The weight vector of the attribute is $\omega_1 + \omega_2 + \omega_3 + \omega_4 + \omega_5 + \omega_6 + \omega_7 = 1$, $\omega = (\omega_1, \omega_2, \omega_3, \omega_4, \omega_5, \omega_6, \omega_7)^T$, $\omega_1, \omega_2, \omega_3, \omega_4, \omega_5, \omega_6, \omega_7 \in [0, 1]$. The patient's intuitionistic fuzzy set multi-attribute decision making problem can be denoted by moments:

$$F = (\langle \beta_{ji}, \eta_{ji} \rangle)_{7\times n} = \begin{pmatrix} \langle \beta_{11}, \eta_{11} \rangle & \langle \beta_{12}, \eta_{12} \rangle & \cdots \langle \beta_{1n}, \eta_{1n} \rangle \\ \langle \beta_{21}, \eta_{21} \rangle & \langle \beta_{22}, \eta_{22} \rangle & \cdots \langle \beta_{2n}, \eta_{2n} \rangle \\ \langle \beta_{31}, \eta_{31} \rangle & \langle \beta_{32}, \eta_{32} \rangle & \cdots \langle \beta_{3n}, \eta_{3n} \rangle \\ \langle \beta_{41}, \eta_{41} \rangle & \langle \beta_{42}, \eta_{42} \rangle & \cdots \langle \beta_{4n}, \eta_{4n} \rangle \\ \langle \beta_{51}, \eta_{51} \rangle & \langle \beta_{52}, \eta_{52} \rangle & \cdots \langle \beta_{5n}, \eta_{5n} \rangle \\ \langle \beta_{61}, \eta_{61} \rangle & \langle \beta_{62}, \eta_{62} \rangle & \cdots \langle \beta_{6n}, \eta_{6n} \rangle \\ \langle \beta_{71}, \eta_{71} \rangle & \langle \beta_{72}, \eta_{72} \rangle & \cdots \langle \beta_{7n}, \eta_{7n} \rangle \end{pmatrix}$$

Attribute influence of patients on n doctors Intuitive fuzzy set moments $O = (O_{ji})_{7\times n} = (\langle \beta_{ji}, \eta_{ji} \rangle)_{7\times n}$, $j = 1, 2, 3, 4, 5, 6, 7$, where $O_{ji}$ is the element in row j row i column in the intuitionistic fuzzy set matrix O, which represents the j-th influence attribute of the i-th doctor. $\beta_{ji}$ is the corresponding fuzzy membership degree, and $\eta_{ji}$ is the fuzzy non-membership degree.

Let $\varepsilon$ be the weighted set counter, and the intuitionistic fuzzy set of the seven factor attributes of the doctors is assembled. Let the comprehensive matrix of doctor attributes be $E = \{e_1, e_2, \cdots, e_n\}$. The calculation formula is as follow:

$$e_i = \langle \theta_i, \delta_i \rangle = \varepsilon(O_{1i}, O_{2i}, O_{3i}, O_{4i}, O_{5i}, O_{6i}, O_{7i}) = \sum_{i=1}^{7} \omega_j O_{ji} = \left\langle 1 - \prod_{j=1}^{7} (1 - \beta_{ji})^{\omega_j}, \prod_{j=1}^{7} \eta_{ji}^{\omega_j} \right\rangle \quad (1)$$

Among them, in the element $e_i$ of the comprehensive matrix, $\theta_i$ is the fuzzy membership degree, and $\delta_i$ is the fuzzy non-membership degree. And $\theta_i$, $\delta_i \in [0, 1]$, $\theta_i + \delta_i \in [0, 1]$.The doctor attributes composite matrix score $\varphi_{ei}$ is calculated as follow:

$$\varphi_{ei} = \theta_i - \delta_i \tag{2}$$

The larger the value, the more deterministic the intuitionistic fuzzy set is. According to the score value $\varphi(e_i)$, all doctors are ordered in decreasing orders, and the Kth score refers to the maximum influence intuition fuzzy set as $g_k = \langle \mu_k, \nu_k \rangle$, k=1, 2, ⋯ n. There is a mapping relationship between the elements in the set $G = \{g_1, g_2, \cdots, g_n\}$ and $E = \{e_1, e_2, \cdots, e_n\}$. The doctor is sorted in descending order, and the weight of the doctor is determined in order. Let the set of position weights of doctors is $\zeta = (\zeta_1, \zeta_2, \cdots, \zeta_i)^T$, $0 \leqslant \zeta_k \leqslant 1$, $\sum_{k=1}^{i} \zeta_k = 1$. Based on the long-tail theory, each weight is assigned, and the weights are decreased in order. Then we use the known trust score to calculate the attribute weight. The weight range is (0, 1), and the weights for all doctor attributes are as follow:

$$\zeta_k = \frac{(1 - \varphi(e_i))}{\sum_{k=1}^{i} (1 - \varphi(e_i))} \tag{3}$$

The doctor-weighted intuition fuzzy set is as follow:

$$g_k' = \langle \mu_k', \nu_k' \rangle = n\omega_k g_k = \langle 1 - (1 - \theta_i)^{n\zeta_k}, \delta_i^{n\zeta_k} \rangle \tag{4}$$

Then there is $g_k'$ and $e_h'$ one-to-one correspondence, and update the value of $e_h'$with $g_k'$, generates a physician attribute-weighted intuitionistic fuzzy set $E' = \{e_1', e_2', \cdots, e_n'\}$ , where $e_h' = \langle \theta_h', \delta_h' \rangle = \langle \mu_k', \nu_k' \rangle$.

The updated doctor attributes composite matrix score is calculated as follows:

$$\varphi(e_h') = \theta_h' - \delta_h' \tag{5}$$

The updated doctor attributes composite matrix score $\varphi(e_h')$ is the score value of $e_h'$, indicating the degree of certainty of $e_h'$. $\varphi(e_h')$ higher value indicates that the corresponding doctor has greater influence.

*3.4 Trust calculation*

Patients receive a high-risk decision-making service on the Internet plus medical platform, and the severity of the consequences of misdiagnosis leads to a high perceived risk of patients. In addition, the inability to communicate with doctors face-to-face and unfamiliarity with online treatment increases the patient's perceived risk, thus affecting the establishment of patients' perceived trust in doctors. Therefore, in order to investigate the influence of perceived risk preference on the establishment of patients' perceived trust, the perceived risk preference coefficient $\lambda$ is added in this paper. And the calculation formula of patient trust after the adjustment of perceived risk coefficient $\lambda$ is as follows:

$$PT = \lambda\theta_h' - (1 - \lambda)\delta_h' \tag{6}$$

Among them, $\lambda \in [0, 1]$ is the patient's risk preference factor.

Let $\lambda \in \lfloor 0, 1 \rfloor$ be the perceived risk coefficient, which is a subjective bias.There are three risk attitudes:

a. When the proportion of $\lambda$ is greater than 50%, the patient is risk-averse, and most of the hesitant prefer to trust.

b. When the proportion of $\lambda$ is equal to 50%, the patient is risk-neutral, and the hesitant prefers half of the two.

c. When the proportion of $\lambda$ is less than 50%, the patient is risk-averse, and most of the hesitant tend to distrust.

## 4.Numerical case study

### *4.1Numerical case design*

Epilepsy is a chronic disease with a total prevalence of epilepsy in China of 7%, and between 400, 000 and 600, 000 people are diagnosed with epilepsy each year. During seizures, patients experience symptoms such as loss of consciousness and delirium. However, due to the small impact of epilepsy seizures in the short term, many people choose not to go to the clinic after the onset of the disease. Because of its convenient and efficient medical treatment, the Internet plus Healthcare can improve the attendance rate of epilepsy patients and play an early preventive role. Therefore, this paper selects epilepsy patients as our research subjects.

Haodf.com is one of the larger Internet plus Healthcare platform. After 15 years of integrity operation, Haodf.com has made remarkable achievements in hospital/doctor information inquiry, graphic consultation, telephone consultation, remote video clinic, outpatient accurate appointment, post-diagnosis disease management, family doctor, disease knowledge science and other fields. And it has been widely trusted by doctors and patients. As of July 2021, Haodf.com has served more than 72 million patients, and more than 2 million patients on the platform have evaluated their visits. Therefore, this article chooses Haodf.com as the platform.

We use the model constructed in this paper to analyze the patient's trust, and the specific algorithm process is as follows:

a. Calculated the doctor attribute synthesis matrix E according to formula (1);
b. Calculate the doctor attributes composite matrix Score $\varphi(e_i)$ according to Equation (2);
c. Calculate the doctor attribute weights $\zeta_k$ according to Equation (3), and update the value according to Equation (4) to generate a new E'; According to Equation (5), updated doctor attributes composite matrix score $\varphi(e'_h)$ is calculated;
d. Calculate trust scores according to Equation (6);

### *4.2 Numerical analysis*

Suppose a patient with epilepsy is seeking a medical treatment on Haodf.com, and browsing the recommended doctors for the treatment of epilepsy provided by the platform. The patient understands the specific information of the three doctors, and the patient's intuition fuzzy set and weight vector of the doctor's trust influence information are as follows:

$$O=\begin{pmatrix} \langle 0.4,0.3\rangle & \langle 0.4,0.1\rangle & \langle 0.3,0.4\rangle \\ \langle 0.5,0.2\rangle & \langle 0.4,0.1\rangle & \langle 0.2,0.7\rangle \\ \langle 0.5,0.1\rangle & \langle 0.6,0.2\rangle & \langle 0.3,0.5\rangle \\ \langle 0.4,0.2\rangle & \langle 0.4,0.2\rangle & \langle 0.5,0.3\rangle \\ \langle 0.5,0.2\rangle & \langle 0.6,0.2\rangle & \langle 0.5,0.3\rangle \\ \langle 0.6,0.2\rangle & \langle 0.5,0.4\rangle & \langle 0.4,0.4\rangle \\ \langle 0.5,0.2\rangle & \langle 0.4,0.3\rangle & \langle 0.4,0.4\rangle \end{pmatrix}$$

The weight vector of the doctor's influence attribute is $\omega = (0.1, 0.11, 0.3, 0.15, 0.12, 0.1, 0.12)^T$.

According to the experimental process a-c, the following results can be obtained as Table 1:

Table 1:Sample Analysis

| Doctor | $E$ | $\varphi_{ei}$ | $\zeta_k$ | $E'$ | $\varphi(e'_h)$ |
|---|---|---|---|---|---|
| A | $\langle 0.488, 0.169 \rangle$ | 0.319 | 0.281 | $\langle 0.431, 0.223 \rangle$ | 0.208 |
| B | $\langle 0.503, 0.195 \rangle$ | 0.308 | 0.286 | $\langle 0.451, 0.246 \rangle$ | 0.205 |
| C | $\langle 0.313, 0.421 \rangle$ | -0.048 | 0.433 | $\langle 0.455, 0.325 \rangle$ | 0.13 |

In order to reflect the influence of different risk preferences on patient trust, we set the perceived risk coefficient $\lambda$=0.2, 0.4, 0.6, 0.8. According to Step d, we obtained the trust level results of patients with different perceived risk preferences as shown in Table 2:

Table 2: Sample Analysis of Patient Trust Scores

| $\lambda$ | Doctor | PT | Rank |
|---|---|---|---|
| | A | -0.0922 | 1 |
| 0.2 | B | -0.1066 | 2 |
| | C | -0.169 | 3 |
| | A | 0.0386 | 1 |
| 0.4 | B | 0.0328 | 2 |
| | C | -0.013 | 3 |
| | A | 0.1694 | 2 |
| 0.6 | B | 0.1722 | 1 |
| | C | 0.143 | 3 |
| | A | 0.3002 | 2 |
| 0.8 | B | 0.3116 | 1 |
| | C | 0.299 | 3 |

*4.3Results*

When the perceived risk preference is not considered, the doctor-weighted intuition fuzzy set $E' = (\langle 0.431, 0.223 \rangle, \langle 0.451, 0.246 \rangle, \langle 0.455, 0.325 \rangle)$ obtained by the patient based on the doctor's information. Three doctors are sorted on the basis of the influence coefficient set score $\varphi(e'_h)$ as A> B>C.

In order to extract the influence of patient perceived risk preference on patient trust, the risk preference coefficient $\lambda$ is taken 0.2, 0.4, 0.6, and 0.8 respectively. According to Table 2, we can see that when the risk preference coefficient $\lambda$ is added, the patient's trust score changes. And when the $\lambda$ value is different, the value of PT is also different. When $\lambda$ takes 0.2, 0.4, the doctor is ranked A>B>C according to the trust score PT, and when $\lambda$ is 0.6, 0.8, the doctor is ranked A> C> B according to the trust score PT. As shown in Table 1, when perceived risk preference is not considered, the PT of the risk neutral patients' trust in the three doctors is significantly higher than that of the risk averse patients' trust in the three doctors, and is significantly lower than that of the risk preference patients' trust in the three doctors. This indicates that when seeing the same doctor attribute information, the trust score PT of risk averse patients will decrease compared with risk neutral patients. And when $\lambda$ is higher, the trust score PT will increase. While the trust score PT of risk preference patients will increase compared with risk neutral patients. And when $\lambda$ is higher, the trust score PT will also increase. In total, the higher the $\lambda$ value, the greater the patient's trust score PT.

The calculation results show that perceived risk preference does affect the patient's perceived trust in the doctor. And the more the patient prefers the risk, the higher the trust in the doctor. The calculations reflect the individualization and differentiation between patient trust traits, and the results are consistent with people's intuitive feelings.

## 5.Conclusion and limitations

In this paper, the patient's perceptual trust is portrayed by the intuitionistic fuzzy set, and the doctor's influence coefficient is calculated by the intuitionistic fuzzy set multi-attribute decision-making method. In order to consider the impact of perceived risk preference on the patient's medical decision-making, we add the perceptual risk preference coefficient $\lambda$, thereby constructing the patient's intuitive fuzzy set considering risk preference, and transforming the objective doctor attribute information into the patient's subjective perceived trust. From the results, we can find that perceived risk preference does affect patients' trust in doctors. And for the attribute information of the same doctor, the higher the perceived risk preference, the higher the patient's trust in the doctor. This implies that the Internet plus Healthcare platform can adopt various feasible means to reduce the risk anxiety of patients, so as to improve the overall trust of patients in the platform doctors and promote the utilization rate of the platform. This method can reflect the ambiguity and subjectivity of patients' perceived trust. In addition, in view of the difficulty in determining the influence weight objectively, an attribute weight calculation method of trust score is proposed. The validity of the method is verified by case analysis and the feasibility of the model is also verified. By calculating the trust score in combination with risk attitudes for doctor selection, it effectively improves the efficiency of patients in choosing a doctor and increases the degree of trust between doctors and patients.

The limitations of this study are as follow. First of all, the subjects selected in this study are the perceived trust of epilepsy patients in doctors, without considering whether patients with other diseases are equally applicable. So the universality of the model needs to be further tested. Secondly this paper only considers the influence of perceived trust on patients' medical choice behavior, but does not consider the influence of perceived recommendation trust caused by comments, which needs to be further studied in the next stage.

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