TASHKENT UNIVERSITY OF INFORMATION TECHNOLOGIES
NAMED AFTER MUHAMMAD AL-KHWARIZMI

ICISCT 2023

INTERNATIONAL CONFERENCE ON INFORMATION SCIENCE AND COMMUNICATIONS TECHNOLOGIES – APPLICATIONS, TRENDS AND OPPORTUNITIES

28th – 30th September, 2023
Tashkent, Uzbekistan

PREFACE

The 2023 IEEE and IFIP International Conference on Information Science and Communications Technologies ICISCT 2023 invites high-quality recent research results in the areas of Home and Health networking, Electronic commerce, Mobility and Mobile Payment, Broadband access, satellite services, 5G in rural communications, cloud computing, Smart grids, Big data analysis, Cyber security, Internet-of-Things IOT, Mobile and Wireless Communications, optical communications and networking, architectures, protocols, planning and design, management and operation, simulation and performance modeling.

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The main goal of the conference is to bring together scientists and engineers who work and teach in these specialized fields to submit papers and come together in this geographical location. ICISCT 2023 is sponsored and organized by IEEE Uzbekistan Regional Chapter and Tashkent University of Information Technologies TUIT and Technically Sponsored by IEEE Photonics Society https://www.photonicssociety.org

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Usmonov Jonibek,

Associate professor, Head of "Mail Communication Technologies" department of Tashkent University of Information Technologies named after

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DETERMINATION OF OPTIMAL DECISION-MAKING CONDITIONS FOR DIAGNOSTICS OF CATTLE DISEASES

1st Muhamediyeva Dilnoz Tulkinovna
National Research University
"Tashkent Institute of Irrigation and Agricultural Mechanization Engineers"
Tashkent, Uzbekistan
dilnoz134@rambler.ru

2th Safarova Lola Ulmasovna
Samarkand State University of Veterinary Medicine, Livestock and Biotechnologies,
Samarkand 140103, Uzbekistan
lola.safarova.81@inbox.ru

3rd Tukhtamuradov Nozir
Research Institute for the Development of Digital Technologies and Artificial Intelligence
Tashkent, Uzbekistan
nozir9407@gmail.com

***Abstract*—The paper considers the determination of optimal decision-making conditions for diagnosing diseases in cattle, since systems for making semi-structured decisions under conditions of various types of uncertainty and, in particular, fuzzy uncertainty, represent an important class of intelligent systems. In designing a fuzzy logic system, the dominant issue is the choice of a rational knowledge base, or rather, a rational number of rules and effective values of their membership functions. In this regard, the paper considers the main problems and tasks of intellectualization of information processing systems and ways to solve them.**

***Index Terms*—Decision making, diagnosis, fuzzy set, model, algorithm, knowledge base, cattle.**

I. Introduction

Intelligent information technologies are created simultaneously with the formalization of professional knowledge and experience of specialists in the field of management, the accumulation and updating of professional knowledge in this area, the development of mathematical models, the processing of empirical knowledge and data, and the construction of a mechanism for the logical inference of analysis results [1].

The paper looks at [2] forms of artificial intelligence (AI) already being implemented in clinical settings, and research into its future use in healthcare is accelerating. Despite this trajectory, more research is needed regarding the impact on patients of increased AI decision making. In particular, the impersonal nature of AI means that its application in highly sensitive contexts of use, such as healthcare, raises issues related to patients' perceptions of (dis)worthy treatment. We explore this issue through an experimental study comparing people's perceptions of dignified and respectful treatment in different health care decision-making contexts. However, we found that for perceptions of respectful and dignified interpersonal treatment, decision makers in diagnostic cases matter more and outcomes matter more in resource allocation cases.

Intellectualization of decision-making systems provides the possibility of forming alternative solutions, disseminating the knowledge and experience of the most highly qualified specialists and formulating a logical argument for the validity of each solution option [2-3].

The decision-making process in management is complicated by the occurrence of fuzziness. In these cases, the apparatus of the theory of fuzzy sets, fuzzy logic and fuzzy inference makes it possible to evaluate the states of such complex situations. With the help of this apparatus, the problems of human behavior in certain situations are successfully solved. If the decision maker is aware of what can happen during the operation of the system, then he will be able to make a more reasonable decision [4].

In conditions when a decision-maker (expert, designer, manager) has to operate with a variety of parameters and conditions that need to be taken into account in the decision-making process, systems designed to support decision-making under conditions of uncertainty can provide invaluable assistance as support, in particular, fuzziness. These include expert and advising decision support systems, which represent an important class of applied intelligent decision support systems.

The basis of all human activity is the decision-making process, which is the choice of one of several choices. We make many decisions without thinking, because we have an automated view of the management of our actions, which is formed in practice. However, there are times when a person has to think deeply and for a long time about a given situation. In such cases, a person is faced with the choice of new types of objects or environment [5-8].

II. Materials and methods

Decision making is usually expressed as follows.

$D = \{d_1, ..., d_i, ..., d_m\}$– a set of choices. For all $d_i \in D$ a function is given $w(d_i)$ indicator of the effectiveness of the variant [3].

Need a better option $d_{i0} \in D$, corresponding to function values $w(d_{i0})$, i.e.

$$d_{i0} = \arg\max w(d_i), d_8 \in D.$$

Function $w(d_i)$ can have different values and mathematical expressions. For example, this can be expressed as follows [9]:

$$W(d) = (q(d), c(d), t(d))^1$$

where $d \in D$ — solution (action, management), formed in accordance with any operator (X – sets of parameters reflecting the problem situation); $q(d)$ – function of efficiency of utility of realization d; $c(d)$ – resource function used to implement d; $t(d)$ –time spent on implementation d.

These functions have both quantitative and qualitative value. All or some of these functions are taken into account depending on the purpose and conditions of the decision-making task.

A clear representation of the functions $d = F(X), q(d), c(d)$ and $t(d)$, where function $W(d)$ itself, as well as all or all factors for finding a value greater than $W(d)$, determines the choice of an appropriate solution method, and this leads to a variety of solutions for the decision problem.

Decisions are divided into political, economic, technical, etc.; by the duration of the activity and the scale of the future - operational, tactical, strategic; according to the appearance of the decision maker - individual and collective (institutional); according to the degree of non-repetition - rigid, non-creative and non-repetitive, creative; according to the degree of uncertainty (completeness of information) - can be in the form of decisions on accuracy, risk (in terms of probable accuracy) and uncertainty [10].

The static model is defined as the decision status. Based on the Wald criterion, such an alternative choice is optimally chosen so that in this case the normalized value is maximum [3]

$$f_{k_0} = \max_{\phi_k \in \Phi} \min_{\theta_j \in \Theta} \overline{f_{jk}}$$

In the process of applying the Wald criterion, the indicators with the smallest value are selected first, and then those with the largest value.

If the $\mu = (\mu_1, ..., \mu_n)$ membership function is given, you can view the dimensions in the following representation [11-14]:

$$\{\mu_j / \sum_{s=1}^{n} \mu_s\}_{j=1}^{n} \text{ and } \{f_{jk} / \sum_{s=1}^{n} f_{sk}\}_{j=1}^{n}$$

where μ is the membership function of the subjective distribution of probability values, and F – the evaluation function for solution $\phi_k \in \Phi$.

The optimal solution $\phi_{k0} \in \Phi$ of the Wald-type criterion in a fuzzy environment is found from the following condition [14]:

$$V(\mu, \phi_{k0}) = \max_{\phi_k \in \Phi} \min_{\theta_j \in \Theta} \sum_{s=1}^{m} f_{jk}^s \mu_s / \sum_{r=1}^{m} \mu_r$$

The optimal strategy for the dynamic decision-making process for the Wald criterion is found using the following recursive equation [3]:

$$f_N^0(\phi_{k_N^0}^N(a_r^{N-1}), a_r^{N-1}) = \min_{\phi_k^N \in \Phi^N} \max_{j=1,...,n_N} f_{jk}^N(a_r^{N-1})$$

,

$$f_l^0(\phi_{k_l^0}^l(a_r^{l-1}) = \min_{\phi_k^l \in \Phi^l} [\max_{j=1,...,n_l} f_{jk}^l(a_r^{l-1}) + \\ + \sum_{r_l=1}^{m_l} f_{l+1}^0(\phi_{k_{l+1}^0}^{l+1}(a_{rl}^l), a_{rl}^l) g_{rl}^l(a_r^{l-1}, \phi_k^l)].$$

A characteristic model of the environment C is formed based on the concepts of fuzzy sets, the use of which made it possible to form a visible state of making a decision of type $\{\Phi, A_0, F\}$, where A_0 - is a fuzzy set or a fuzzy random state C, determined by μ_A- membership function and distributed by probability P.

When solving the problem, we use the Bayes criterion and recurrent equations for the mathematical expectation of the Bayesian value of the evaluation functional.

Let some solution be given [13-15]

$$\phi = (\phi_{k_1}^1, ..., \phi_{k_l}^l) \in \Phi = \{\Phi^1, ..., \Phi^l, \ \Phi^{l+1}, ..., \Phi^N\},$$

Let $f_l(\phi_{k_1}^1, ..., \phi_{k_l}^l)$ - the total mathematical expectation of the Bayesian value of the evaluation functional on solution $\phi_{k_1}^1 \in \Phi^l$ when using solutions $f_l(\phi_{k_1}^1, ..., \phi_{k-l}^{l-1})$ at $1, 2, , ..., (li0)$ -th stages and optimal solutions at $(l+1), ..., N$-th stages, equal to [9-10]

$$f_l(\phi_{k_1}^1, ..., \phi_{k_l}^l) = f_{l+1}(\phi_{k_1}^1, ..., \phi_{k_l}^l, \ \phi_{k_{l+1}^0}^{l+1}) + \\ + \sum_{\nu=1}^{m_{l-1}} B^l(\phi_{k_l}^l \left| a_\nu^{l-1}) \Re(a_\nu^{l-1} \right| \phi_{k_1}^1, ..., \phi_{k_{l-1}}^{l-1}),$$

where $B^l\left(\phi_{k_i}^l | a_v^{l-1}\right) = \sum_{j=1}^{n_l} p_j^l f_{jk_l}^l(a_v^{l-1})$ - Bayesian value of the evaluation functional; $f_N(\phi_{k_1}^1, ..., \phi_{k_N}^N)$)- And the mathematical expectation of the Bayesian value of the evaluation functional on the set of solutions $\phi_{k_N}^N \in \Phi^N$ when using $\phi_{k_1}^1, ..., \phi_{k_{N-1}}^{N-1}$ [11]:

$$f_n(\phi_{k_1}^1, ..., \phi_{k_{N-1}}^{N-1}) = \sum_{v=1}^{m_{N-1}} B^N(\phi_{k_N}^N | a_v^{N-1}) \Re(a_v^{N-1} | \phi_{k_1}^1, ..., \phi_{k_{N-1}}^{N-1})$$

Here

$$B^l(\phi_{k_j}^l, a_r^{l-1}) = \sum_{j=1}^{k} p_j^l f_{jk}^l(al - 1_r),$$

$$f_{jk}^{i}(a_r^{i-1}) = \sum_{S=1}^{k} \mu_{jk}^{S}(a_r^{i-1}) / \sum_{j=1}^{n} \mu_j,$$

$$\mu_j = \sum_{S=1}^{k} \mu_{ji}^{S}.$$

Solution $\phi^0 = (\phi_{k_1^0}^1, ..., \phi_{k_N^0}^N)$ is called the optimal solution according to the Bayes criterion (in the absence of a source of information on the object) and can be found, starting from the last N-th stage and ending with the l-th stage, as follows.

For the N th stage, the optimal decision strategy $\phi_{k_k^0}^{N^0} = (\phi_{k_1}^1, ..., \phi_{k_{N-1}}^{N-1} \in \Phi_0^N)$ or all possible combinations of solutions $\phi_{k_1}^1, ..., \phi_{k_{N-1}}^{N-1} \in [01]$ is found from the condition [14].

$$f_l(\phi_{k_1}^1, ..., \phi_{k_{N-1}}^{N-1}, \phi_{k_N^0}^N) = \min_{\substack{\phi_{k_N}^N \in \Phi^N \\ T_N(\phi_{k_1}^1, ..., \phi_{k_N}^N)t}}$$

$$\sum_{\nu=1}^{m_{N-1}} B^N(\phi_{k_N}^N \left| a_\nu^{N-1}) \Re(a_\nu^{N-1} \right| \phi_{k_1}^1, ..., \phi_{k_{N-1}}^{N-1}).$$

For any l-th stage $(l = N-1, ..., 1)$ the optimal strategy $(\phi_{k_1}^1, ..., \phi_{k_l}^{l-1})$ is found from the condition [3,15]

$$f_l(\phi_{k_1}^1, ..., \phi_{k_{l-1}}^{l-1}, \phi_{k_l^0}^l) = \min_{\substack{\phi_{k_l}^l \in \Phi^l \\ T_l(\phi_{k_1}^1, ..., \phi_{k_l}^l \left| \phi_{k_{l+1}^0}^{l+1}, ..., \phi_{k_N^0}^N, \phi_{k_l}^l \right.) = t}}$$

$$\left[f_{l+1}(\phi_{k_1}^1, ..., \phi_{k_{l-1}}^{l-1}, \phi_{k_{l+1}^0}^{l+1}) + \right.$$

$$\left. + \sum_{\nu=1}^{m_{N-1}} B^N(\phi_{k_N}^N \left| a_\nu^{N-1}) \Re(a_\nu^{N-1} \right| \phi_{k_1}^1, ..., \phi_{k_{N-1}}^{N-1}) \right],$$

where $T_N = (\phi_{k_1}^1, ..., \phi_{k_N}^N)$ – expectation of the transition time of an object from the initial state to one of the final states when using solutions $(\phi_{k_1}^1, ..., \phi_{k_N}^N); T_l = (\phi_{k_1}^1, ..., \phi_{k_l}^l) | (\phi_{k_{l+1}^0}^{l+1}, ..., \phi_{k_N^0}^N)$ – he mathematical expectation of the transition time of the object from a^0 to a^N when using at stages $1, 2, ..., l$ solutions $\phi_{k_1}^1, ..., \phi_{k_l}^L$ and at subsequent stages $(l+1), ..., N$ optimal solutions $\phi_{k_{l+1}^0}^{l+1}, ..., \phi_{k_N^0}^N$

III. RESULTS

Diagnosis is an important task of modern information and communication technologies and decision-making when building a model for diagnosing and managing them under conditions of uncertainty [2,14].

The application of signs or the level of confidence can be shown using the following fuzzy-logical knowledge base for diagnosing diseases in cattle [15]:

$\exp(-\frac{1}{10}(x-2)^2)$	$\exp(-\frac{1}{3}(x-1)^2)$	$\exp(-1\frac{1}{3}(x-1)^2)$	$\exp(-5(x-1)^2)$	$\exp(-\frac{2}{5}(x-0)^2)$	1
$\exp(-\frac{1}{3}(x-1)^2)$	$\exp(-1(x-0)^2)$	$\exp(-15\frac{7}{38}(x-1)^2)$	$\exp(-25(x-2)^2)$	$\exp(-9\frac{1}{11}(x-1)^2)$	
$\exp(-\frac{4}{9}(x-2)^2)$	$\exp(-\frac{1}{3}(x-1)^2)$	$\exp(-2\frac{16}{17}(x-2)^2)$	$\exp(-\frac{5}{9}(x-2)^2)$	$\exp(-\frac{1}{31}(x-2)^2)$	
$\exp(-\frac{1}{8}(x-1)^2)$	$\exp(-1(x-2)^2)$				

Fig. 1. Result fuzzy-logic knowledge base for diagnosis

IV. DISCUSSION

It is possible to single out the main property of the characteristic of the diagnostic task of cattle diseases - that is, the final point of decision-making is set by a veterinarian. Diagnosis of diseases in cattle is made on the basis of 17 signs of disease, as decision-making issues are one of the most relevant in modern science over the past decade. It is known that the correct operation of a particular system can be achieved as a result of the work of this system in collecting, analyzing, choosing the correct processing, as well as developing the correct managerial influence on them [16].

The knowledge base is a reflection of the intellectual activity of a veterinarian: reflections, conclusions, generalizations of abstraction, which are based on various knowledge - fundamental in scientific research, subjective, obtained as a result of practical activities and experience in veterinary medicine.

The basis for the formation of the knowledge base is the following information [17]:

- a set of information about possible signs of situations and their classification. Signs can be, for example, temperature, pulse at one minute, respiration at one minute, rumination at two minutes, red blood cell count, hemoglobin, total protein, total calcium, organic phosphorus, glucose, reserve alkali, copper, cobalt, manganese, zinc, the number of infusoria, the state of cicatricial fluid;
- information about the causes of certain signs of situations, their classification and systematization;
- information about actions (or a set of actions) to eliminate situations that have arisen for appropriate reasons.

One of the main objectives of this study is an attempt to develop and implement models of weakly formalized processes, such as diagnosing diseases in cattle with fuzzy initial information, expressed in the form of logically justified linguistic statements [18,19].

V. CONCLUSION

The implementation of the system provides:

- improving the quality of group decision-making in the conditions of various situations due to computer decision-making and machine experiment with imitation of the corresponding situation;
- the possibility of developing management decisions and recommendations to reduce human and material losses;
- saving resources (material, labor) due to the simulation of collective decision-making on a computer, the multivariance

of the decisions obtained and the effective use of pre-prepared decisions in real conditions;

- increasing the effectiveness of training based on the use of modern computer technology and software, mathematical methods and software systems.

The mathematical apparatus used is quite laborious in terms of computational procedures. Therefore, the effectiveness of its use is achieved in the presence of special computer developments.

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