The quality of population: the proportion of employees with higher education organizations, age dependency rate, rate of natural increase, rate of migration increase, life expectancy.

The investment attractiveness: share of innovation-active organizations in the total number of surveyed companies.

The standard of living: population provision with housing, the ratio of per capita income to the minimum subsistence budget, paid services for population, retail turnover of trade.

Quality of social services: provision with doctors.

Conclusion. In order to solve the identified problems it is, first of all, necessary to create new jobs and thus attract young working population to regions, as well as to implement a package of measures stimulating the development of small and medium businesses in the fields of material production, innovation and provision of public services.

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APPLICATION OF FUZZY DECISION TREES FOR TEACHING THE SYSTEM OF RECOGNITION OF OBJECTS OF INTELLIGENCE AND THEIR STATES OF ACTIVITY BASED ON THE FUZZY APPROACH

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In [1] in the interests of automated recognition of intelligence objects and their activity states with insufficient accumulated statistical information, the authors showed the feasibility of applying an approach based on the theory of fuzzy sets and the fuzzy logic method, in which each of the «arguing» recognition objects is assigned its own degree accessories on the basis of which the duty officer makes a decision. After assessing the reliability of the recognition result obtained, this information is taken into account as accumulated statistical data, which are then used in the formation and refinement of the rules of the fuzzy knowledge base. To train this knowledge base, both statistical data accumulated from the experience of conducting intelligence and expert assumptions (method of expert estimates) are used. However, in view of the subjectivity of the assumptions made, the training of the knowledge base will take a long time and with a deterioration in the quality of decisions regarding the recognition result.

For training a fuzzy knowledge base (both at the initial stage and in the systematic refinement of fuzzy rules), it is proposed to use fuzzy decision trees

(a combination of the capabilities of decision trees and fuzzy logic) [2, 3]. This is a well-known and popular method of data analysis, which is based on learning from examples – the training sample. Unlike decision trees, where each example of a training set belongs to a specific internal node of the tree that gives the solution, instead of the number of examples of a particular node, their degree of membership is grouped in a fuzzy tree.

The purpose of this research is to demonstrate the appropriateness of using fuzzy decision trees for training intelligence recognition systems and their activity states based on a fuzzy approach.

Material and methods. The material of this research is a technique for automated recognition of intelligence objects and their activity states, based on the theory of fuzzy sets and the fuzzy logic method, considered in [1]. In the interests of preparing the source data for the qualitative use of the named methodology, instead of the expert assessment method in the formation of a fuzzy knowledge base, such a data mining method as fuzzy decision trees was used.

Findings and their discussion. As the initial data, a training set is used in the form of statistical data for the period (for example, for 1 year) on the recognition of reconnaissance objects on the basis of the values of signs identified at the reconnaissance posts. At the stage of preparing data for the proposed algorithm, the drug is determined and the rules of the fuzzy knowledge base are built on the basis of the available statistical data. The method of fuzzy decision trees will allow, based on the existing classification objects of intelligence and the presented training sample, to build and train a fuzzy decision tree (training with a teacher), on the basis of which to create the missing logical rules of a fuzzy knowledge base by launching a system of rare or unpopular values of these intelligence signs (IS).

The algorithm for constructing a fuzzy decision tree consists of the following steps:

1. Implementation of fuzzification – determination of membership functions for the conditions of each example (rule) based on the obtained values of IS z_k, $(k=\overline{1...K})$.

2. Calculation of the affiliation coefficient of training examples to each of the outcomes (recognition results) P_i^N.

3. Calculation of the common membership coefficient of all examples P^N.

4. Definition of total entropy $E(R_N)$, i.e. the average amount of information to determine the class of an object A_i from the set of membership coefficients of all examples.

5. Calculation of entropy for partitioning for each IS with their linguistic values $E(R_N, z_k)$.

6. Definition of IS with the maximum increase in information $z = \arg\max_{z_k} G(R_N, z_k)$ from which the partition begins.

7. Calculation of the degree of belonging to each new node for each record $\mu_{N|j}(T_S(z_k))$. Those nodes to which no record belongs, i.e. $\mu_{N|j}(T_s(z_k)) = 0$, are removed from the tree. An example of a fuzzy decision tree for two identified clear IS values is presented in Fig. 1.

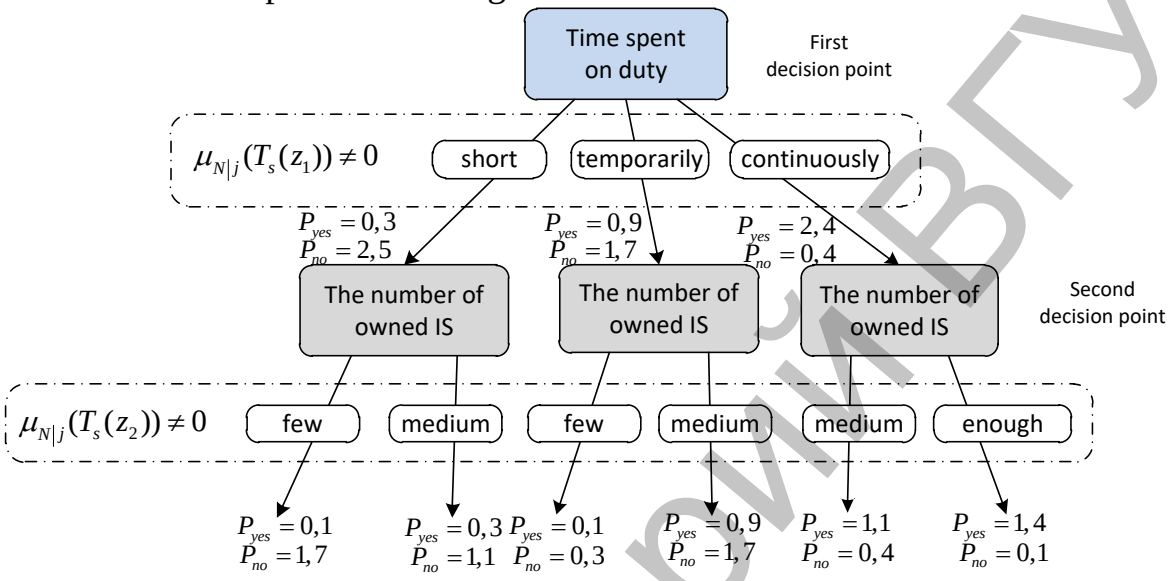

Fig. 1 – An example of a fuzzy decision tree for two IS

8. Based on the resulting tree, indicating the value of each of the signs by which a decision is made, the identification of the identified IS values to the target class is carried out $\sigma(A_i)$.

The advantages of this approach are the fast learning and decision making process, visualization and high recognition accuracy, comparable to the accuracy of other classification methods, such as statistical methods, neural networks, etc. [2–4], achieved by combining the advantages of fuzzy logic and decision trees . Since the algorithm is capable of producing not only a class for a new object, but also the degree of belonging to it, this allows us to control the threshold for recognition.

Conclusion. Thus, the use of fuzzy decision trees for training a fuzzy knowledge base will make it possible to give more objective assessments of predicting recognition results with specific values of degrees of belonging. The construction of fuzzy decision trees is advisable to be carried out automatically, for example, using a data mining add-in (Data Mining) Microsoft Excel.

Fuzzy decision trees used in data mining for solving classification problems, as well as regression, when it is necessary to know the degree of belonging to a particular outcome, have found wide application, including in military affairs: when modeling decision-making by an automated control system operator, to form the preferred algorithm for the activity of the person

making the decision on the available set of data on the problem being solved, for the classification of military personnel on a contract basis, etc.

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THE USE OF MATHEMATICAL MODELS OF TOPOLOGICAL OBJECTS IN THE STUDY OF PROPERTIES OF TOPOLOGICAL MANIFOLDS

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One of the ways to improve the quality of education is to enrich the school course with subjects that contribute to the broad development of key skills of the 21st century: creativity, critical thinking, cooperation and communication. Elements of general topology are not explicitly studied in the course of school mathematics, but, as you know, topological representations of a person appear before spatial and metric ones [2]. Students, starting from grade seven, operate on such basic topological concepts as internal, external and boundary points, geometric body, surface, internal and external areas, border, etc. These concepts lay the foundation for the further formation of spatial and metric representations of students, as well as to study the topology [2]. The study of topology contributes to the development of spatial thinking, effectively affects the development of creativity and plasticity of thinking of students. Mathematical modeling allows you to consider the object / topic more clearly, allowing you to notice more details and the picture as a whole. Thus, the use of mathematical modeling to study the properties of topological manifolds is relevant.

The aim of the work is to analyze the efficiency of using the method of mathematical modeling when studying the properties of the main topological manifolds on the basis of the developed elective course "Get to know the topology".