DIALOGUES WITH SPECIALISTS

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APPROACHES TO CREATING ARTIFICIAL INTELLIGENCE

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Abstract. Approaches to creating artificial intelligence systems based on expert systems, genetic algorithms, game theory, and neural networks are considered; knowledge representation tools in artificial intelligence systems are based on symbolic patterns, sets of standard operations and procedures for finding solutions.

The process of searching for solutions in artificial intelligence systems based on logical inference systems, which have the form of a semantic network with elements of conjunction and disjunction, is considered in detail.

The features of a semantic network, which is an arbitrary graph (AND / OR network) and implements two methods of logical inference – forward and reverse wave methods are considered.

An example of an artificial intelligence model in the form of a fuzzy expert system containing a knowledge base consisting of fuzzy production rules is considered in detail. Said artificial intelligence model is used to assess the risk of an emergency occurring when the water level rises during a flood.

The considered fuzzy expert system, implemented in the form of a computer program, which makes it possible to assess flood risk in conditions of incomplete and inaccurate initial data.

Key words: artificial intelligence, neural networks, genetic algorithms, game theory, expert systems, knowledge representation, logical inference system, semantic networks, fuzzy sets

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Introduction

Artificial intelligence (AI) is the property of artificial intelligent systems to perform creative functions that are traditionally performed by humans, as well as the technology for creating intelligent computer programs.

Let's formulate the problem statement for this article: to consider practical approaches to solving the problem of creating AI.

The relevance of the problem of developing AI systems that can be used, among other things, for risk assessment, decision-making, natural language processing (112 emergency service) and images in fire safety and warning systems is constantly increasing, and many works have been devoted to the topic of AI [1–10].

Theoretical approaches to creating AI

Despite the existence of many approaches both to understanding the tasks of AI and to creating intelligent information systems, two main approaches to AI development can be distinguished [1]:

1. Top-Down AI, semiotic – creation of expert systems, knowledge bases and logical inference systems that simulate high-level mental processes: thinking, reasoning, speech, emotions, creativity, etc.

2. Bottom-Up AI, biological – the study of neural networks and evolutionary computing (genetic algorithms) that model intelligent behavior based on biological elements, as well as the creation of appropriate computing systems such as a neurocomputer or a biocomputer.

Practical approaches to creating AI models

The following approaches to creating AI models can be distinguished:

– models that use adaptation to the problem being solved by changing the connections between neurons in a neural network;

– models that use adaptation to the problem being solved by creating populations of competing solutions that are improved based on genetic algorithms;

– models based on game theory, where adaptation to the problem being solved is performed by creating a state space, and a heuristic approach is used to find optimal states, allowing you to change the order of iteration of solutions to the problem;

– models based on expert systems, where adaptation to the problem being solved is made by borrowing knowledge from an expert, including an understanding of the problem and a set of heuristic rules for solving it. However, expert systems can only be used for well-studied subject areas.

Knowledge representation in AI

The intellectual activity of the AI model can be performed using the following templates, sets, and procedures for solving the problem [1]:

– procedures for searching for possible options;

– sets of operations for creating options;

– symbolic templates for describing the definition area.

A. Turing's theory of algorithms [11] states that if a computer performs efficient processing of symbolic information, then it has intelligence.

There are two main issues that need to be addressed on the path of AI research:

1) identify the structures, symbols, and operations for solving the problem;

2) using structures, symbols, and operations, determine effective strategies for finding solutions to the problem.

At the same time, some scientists consider intellectual abilities to be inherently biological, which means that a computer does not possess intelligence.

Solving the problem of knowledge representation is especially important for the approach to creating AI through the use of expert systems. The basis of such an AI system is a knowledge base and a logical inference system, which is used to automatically construct an algorithm for solving a problem based on templates (ready-made modules and subprograms).

The languages of the calculus of propositions or predicates containing production rules are currently used to describe knowledge. Their simplified form is languages based on products in the form of the statement «If... then...».

All cause-and-effect statements also apply to products.

Finding solutions in AI

The logical inference system in an AI system can contain a decision tree in the form of a single-sided graph with vertices (statements) and arcs (procedures for creating new statements) [2]. By definition, graphs formally allow us to describe many similar situations. The vertices of such a graph can be divided into two groups, forming conjunctive (AND) and disjunctive (OR) conditions of logical inference.

In general, the inference scheme can take the form of an arbitrary graph or network. This inference scheme is based on the forward wave method (from the initial vertices of the graph to its target vertex) and the reverse wave method (from the target vertex of the graph to its initial vertices).

The traditional approach to creating a logical inference procedure involves the use of an iterative process, the feature of which is that as the number of heuristic rules for solving a problem increases, the computational complexity of the solution increases.

Modern AI systems are capable of solving problems containing thousands of variables and heuristic decision rules. The approach to creating logical inference systems in the form of AND / OR networks (graphs) allows us to solve such problems.

AND / OR logical output network

Let the AND / OR network contain two types of elements: objects O (vertices of the graph) and rules R (edges of the graph), with the vertices of the graph storing information about the edges of the graph, and the rules R storing information about the output Y and input X variables.

All adjacent edges and vertices of the graph are defined in each element of the AND / OR inference network. All information about the graph implementing the AND / OR inference network is stored as an adjunction matrix [11].

The junction matrix of the graph G = (V, E), where V are vertices; E are edges, is written as a two-dimensional array of size N × N, where N is the number of vertices.

In a directed graph (digraph), the edges are provided with arrows and are ordered pairs of vertices: the first vertex is the beginning of the edge, the second is the end. The arrows indicate the acceptable direction of movement along the edge. A complete graph is a graph in which each vertex is connected to all others [11].

An example of a directed graph is shown in fig. 1.

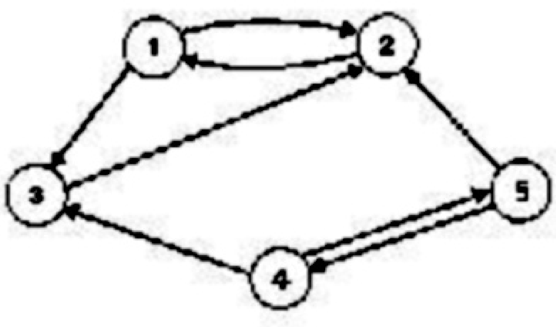

Fig. 1. **A directed graph G = (V, E)**

A formal description of the graph presented above, has a form: G = ({1,2,3,4,5}, {(1,2), (1,3), (2,1), (3,2), (4,3), (4,5), (5,2), (5,4)}).

The adjacency matrix for this graph has the following form (fig. 2):

	1	2	3	4	5
1	0	1	1	0	0
2	1	0	1	1	0
3	1	1	0	0	1
4	0	1	0	0	1
5	0	0	1	1	0

Fig. 2. **The matrix of junctions**

In each cell [i, j] of the adjacency matrix, 1 is written if an edge of the graph leads from vertex i to vertex j, otherwise 0 is written to cell [i, j].

Fig. 3 shows a list of junctions for the graph shown in fig. 1. The list of junctions for a directed graph G = (V, E) is a one–dimensional array of length N (N is the number of vertices of the graph). Each element of the array is a reference to the list of junctions [11].

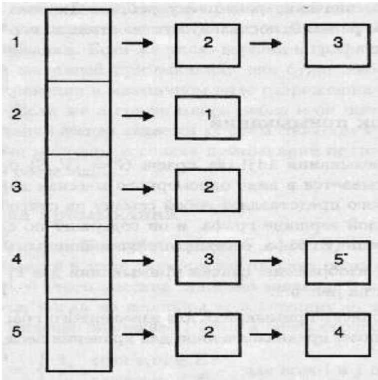

Fig. 3. **List of junctions**

An example of an AI model in the form of an expert system

The expert system contains a knowledge base that implements a production model of knowledge representation in the form of a set of statements, and a set of heuristic rules for solving a problem.

The considered model of a fuzzy expert system is based on fuzzy sets and contains a knowledge base presented in the form of fuzzy production rules [5–9]. Fuzzy production rules can have the following form: If «Condition 1», then «Conclusion 1» (F), where F is the uncertainty coefficient of the corresponding rule. Simple or compound statements related to the logical operations of conjunction (AND) and disjunction (OR) are used as conditions and conclusions of the rules.

As an example of the rule base for the fuzzy inference system of a fuzzy expert system, let's consider the rule base for assessing the risk of a natural disaster – rising water levels during a flood. The following values were used as variables: Y – the value of the water level rise (ΔU), X2 – the value of the air temperature rise (ΔT), X1 – the value of the height difference (ΔH). The fuzzy inference system used the following rule base:

IF the temperature rise is equal to ΔT **AND** the height difference is equal to ΔH, **THEN** the water level will change by an amount equal to ΔU(F). Using expert assessments, the values of ΔH and ΔT were obtained. Further, a certain range of values of the uncertainty coefficient F was assigned to each range of values of variables X1 and X2.

To conduct computational experiments, a fuzzy expert system (computer program) was created [10], using which the dependence ΔU = f(X1, X2) was investigated. The use of a fuzzy expert system made it possible to assess the risk of a natural disaster (flood) in conditions of incomplete and inaccurate initial data. The interface of the computer program is shown in fig. 4:

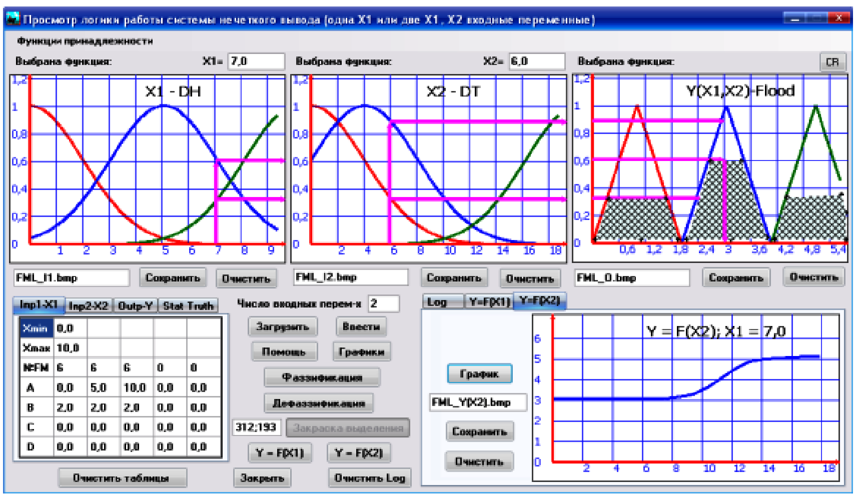

Fig. 4. **Computer program interface**

Conclusion

The problems of developing AI systems that can be used, among other things, for risk assessment and decision-making are among the urgent problems. AI systems can be created through various approaches based on neural networks, genetic algorithms, game theory, and expert systems. The implementation of an AI system based on a fuzzy expert system makes it possible to make decisions in conditions of uncertainty, in the case of incomplete and inaccurate initial data.

The scientific novelty of the research, reflecting the author's personal contribution, is the creation by the author of computer models of fuzzy inference systems, neural networks, genetic algorithms and expert systems [12].

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