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SYSTEM FOR ASSESSING THE FINANCIAL WEALTH OF CLIENTS ON THE BASIS OF FUZZY RULES

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Abstract

This article is devoted to the use of fuzzy modeling in making poorly structured financial and economic decisions. The article considers the definition of a decision-making problem, its general representation, as well as the types of decision-making problems based on fuzzy logic. The problem of assessing the creditworthiness of bank customers using Python tools is mathematically formulated.

Key words: fuzzy sets, fuzzy modeling, decision making.

1. Introduction

The fuzzy modeling process is a sequence of interrelated steps, each of which is performed in order to use a fuzzy model of the system to solve the original problem. The apparatus of the theory of fuzzy sets, which is the basis of the model developed in this paper, makes it possible to find a solution to this problem under conditions of uncertainty, as well as weakly structured evaluation indicators, without resorting to the use of expert assessments. The main advantage of using this apparatus is the ability to create quantitative estimates for linguistic variables, as well as effectively display the relationship between these variables in the form of fuzzy rules [1.2]

2. Mathematical models and information technologies are the basis for improving the quality and efficiency of economic decisions.

The task of decision making (DPR) is one of the most common in any subject area. Its solution comes down to choosing one or more of the best alternatives from a set. In the general case, the RRP can be represented as follows:

$$\{T, A, K, X, F, G, D\},$$

where: T - problem statement (for example, choose the best alternative or arrange the entire set); A is the set of acceptable alternatives; K is a set of selection criteria; X is a set of methods for measuring preferences (for example, using different scales); F - mapping of the set of feasible alternatives into the set of criteria-based assessments (outcomes); G - system of preferences of the expert; D is a decision rule reflecting the system of preferences. Any of the elements of this set can serve as a classification feature for decision making. DPR can be classified in many ways. Determining the type of problem helps to understand its specifics and choose the most appropriate solution methods. When managing complex financial and economic processes, a decision maker (DM) is increasingly faced with uncertain, poorly structured problem situations. In this case, analytical decision support based on traditional mathematical methods and information technologies cannot provide the required level of quality and

management efficiency. To effectively solve such problems, it is advisable to use intelligent mathematical models of artificial intelligence (AI) for analytical decision support

3. Fuzzy modeling (Fuzzy-technologies) as a means of automating the adoption of complex financial and economic decisions.

Fuzzy logic is regarded as a standard modeling and design method. Systems based on fuzzy sets have been developed and successfully implemented in such areas as medical diagnostics, technical diagnostics, financial management, personnel management, stock forecasting, pattern recognition, mineral exploration, fraud detection, computer network management, process control, logistics and many others. One of the most effective fuzzy modeling software and information tools is Python.

Python is an actively developing programming language. The rich standard library is one of its attractions. There are tools for working with many network protocols and Internet formats, for example, modules for writing HTTP servers and clients, parsing and creating mail messages, working with XML, etc. A set of modules for working with the operating system allows you to write cross-platform applications . There are modules for working with regular expressions, text encodings, multimedia formats, cryptographic protocols, archives, data serialization, unit testing support, etc.

For example, 1) pyinference.fuzzy.domain module - A module that describes various types of fuzzy set media, and also implementing the functionality of fuzzy rules of logical inference.

2) pyinference.fuzzy.set module - Module for working with fuzzy sets. The module implements the functionality of the fuzzy logic apparatus in terms of working with fuzzy sets. It includes: an abstract fuzzy set class, templates for creating classifiers of various types. Basically, the module is designed to create and use fuzzy classifiers. With it, you can create a classifier both manually and fill it with terms yourself, or use one of the constructors described below.

3) Module contents is a library for working with the apparatus of fuzzy logic.

This library contains a number of modules designed to ensure the use of fuzzy logic in economic and mathematical modeling. It includes the following sections:

- various carriers of fuzzy subsets: from the real interval to
- hierarchical structures
- fuzzy subsets: arithmetic, logical operations
- fuzzy numbers, fuzzy arithmetic
- fuzzy sets, classifiers
- fuzzy inference, fuzzy controllers
- method of analysis of hierarchies.

4) To visualize fuzzy logic using the Python programming language, you need to connect a number of modules, namely:

– Scikit-fuzzy (Skfuzzy) is a package for working with fuzzy logic in Python that works with NumPy arrays [6];

– NumPy is a package for scientific computing in the Python language, which is distinguished by the ability to work with multidimensional arrays [7];

– Matplotlib is a comprehensive library for creating static, animated and interactive visualizations in Python [8].

4. The task of assessing the creditworthiness of bank customers.

At present, in the context of the crisis of the banking system, one of the urgent tasks is to assess the creditworthiness of bank customers. The essence of the problem under consideration is as follows. When issuing long-term loans to individuals, banks traditionally use the method of expert assessments to assess the solvency of customers, which introduces a certain subjective error into the assessment mechanism. A meaningful interpretation of a fuzzy model involves the

choice and specification of input and output variables of a fuzzy inference system. It is proposed to use 6 input variables and 1 output variable in the fuzzy model:

X1 - income level;

X2 - Down payment;

X3 - Age of the client;

X4 - Work experience;

X5- Active debts;

X6 - Retirement savings of the client.

As an output variable, the creditworthiness score is used, which is the basis for making a decision by the bank's management on granting a loan. At the same time, the decision to grant a loan by the bank's management is made only in the case of a high assessment of this output variable. The implementation of fuzzy inference involves a certain sequence of steps:

1) Formation by a bank employee for a potential client of a clear vector of scores {□1, □2, □3, □4, □5}.

2) Fuzzification.

3) Aggregation.

4) Activation.

5) Accumulation.

6) Defuzzification.

We will develop a fuzzy model using the above Python tools. To solve the problem of fuzzy modeling, we use the Mamdani algorithm [3,4].

The algorithm is remarkable in that it works on the principle of a "black box". Quantitative values come at the input, they are the same at the output. At intermediate stages, the apparatus of fuzzy logic and the theory of fuzzy sets are used. This is the elegance of using fuzzy systems. You can manipulate familiar numerical data, but at the same time use the flexibility that fuzzy inference systems provide.

At the same time, for the logical operations "AND" and "OR" we use the max and min methods, and for implication, aggregation and defuzzification, respectively, the max, min and centroid methods.

Further, for each variable, using the membership function editor, we build term sets with the corresponding linguistic meanings of terms and the membership function itself. Let's set 40 rules for the developed fuzzy inference system using the Python rules editor. In this case, to enter the entire set of terms and rules, you must use scrolling. Now it is possible to analyze the constructed system of fuzzy inference to solve the problem. To do this, "play" with the system. Let's set the following values of the input variables: □1= 8, □2= 8, □3= 9, □4= 9, □5= 5 These are quite high estimates of the input variables, which even on an intuitive level testify in favor of the client. The developed fuzzy inference system gives Y=7.93 in response to these input data. This is a fairly high value for the client's credit rating, which is well consistent with intuitive considerations.

Let's change the input data in such a way that it is intuitively clear that this client has a low creditworthiness, for example: , the client has low financial viability. This may serve as the basis for a negative decision of the bank.

Thus, the constructed system of fuzzy inference shows its efficiency and its solutions are in good agreement with the intuition of bank employees. To analyze the developed fuzzy model, you can use the visualization of the corresponding fuzzy inference surface. This surface allows you to evaluate the dependence of the output variable Y "creditworthiness" on the values of various pairs of input variables. The analysis of these dependencies can serve as a basis for changing the parameters of the fuzzy inference model to increase its adequacy for various bank strategies.

5.Conclusion

The paper analyzes the intelligent mathematical models of artificial intelligence (AI) and their main properties, as well as the basic elements of the theory of fuzzy modeling, the main terms and definitions that underlie the theory of fuzzy modeling. Graphical tools that implement the use of fuzzy inference systems are analyzed. As a result, the problem of assessing the creditworthiness of customers is mathematically formulated using Python tools.

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ТЕХНИКАЛЫҚ УНИВЕРСИТЕТТЕ БІРТЕКТІ ЕМЕС ТҰРАҚТЫ, АЙНЫМАЛЫ КОЭФФИЦИЕНТТІ ДИФФЕРЕНЦИАЛДЫҚ ТЕҢДЕУЛЕРДІ ШЕШУДІҢ ОПЕРАТОРЛЫҚ ӘДІСТЕМЕСІ

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Аңдатпа

Қ.И. Сәтбаев атындағы техникалық университетте оқытылатын барлық мамандықтарға «Қарапайым дифференциалдық теңдеулер және Matlab» пәні енгізілді. Инженерлік мамандықтарда оқитын студенттерді біртекті емес тұрақты, айнымалы коэффициентті дифференциалдық теңдеулерді шешу қызықтырады. Алайда мұндай теңдеулерді шешудің барлығына бірдей ортақ әдістемесі жоқ. Оқу бағдарламасында біртекті емес теңдеулердің дербес шешімдерін табу үшін анықталмаған коэффициенттер және тұрақтыны вариациялау әдістері қолданылады. Бұл мақалада Хевисайдтың символдық әдістемесіне негізделген сызықтық дифференциалдық теңдеулерді шешудің операторлық әдісі қарастырылады.

Түйін сөздер: дифференциалдық теңдеу, тұрақтыны вариациялау, операторлық әдіс, сызықтық теңдеу, Бернулли теңдеуі, Эйлер теңдеуі, интегралдау операторы.