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ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
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Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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EVALUATION OF THE CHOICE OF BORROWER RATING GROUPS

Abstract. Application of intellectual methods for information processing is a new step in improving business efficiency by means of introduction of modern technologies, including digitalization tools. As a rule, the construction of operations for solving specific tasks is carried out by experienced specialists to a large extent intuitively, and the solution of each new task requires the entire work anew. The result is that very often a rather large part of the data remains unprocessed and unclaimed. This is a significant disadvantage of the current situation, which determines the main requirement for promising approaches to solving applied data processing tasks: the simplicity and reliability of complex procedures excluding intuitive work of specialists must be provided. The paper touches upon the methodological problems of credit risks in banking operations and shows the advantages of using recognition algorithms based on the precedent approach. This helps to reduce the risk of losses and make a profit, as well as to justify decisions when working with borrowers. Stressing the importance of traditional approaches, we note that using the proposed approach allows to obtain a more accurate and objective result, to operate with large data sets, to optimize customer service, to calculate the effectiveness of investments with minimal human impact.

Key words: decision support; a precedent approach; multicriteria selection; algorithmic support; artificial intelligence, bank, efficiency, globalization, client, digitization.

Introduction. Nowadays the society is on the verge of a new era of the digital society and the digital economy. The problem of globalization and acceleration in all spheres of the society activities is of a systemic nature; therefore, it is necessary to correctly evaluate the prospects, advantages, and risks connected with it. Creating information processing tools is a new step in improving business efficiency through the introduction of modern technologies, including digital transformation tools. The application of artificial intelligence systems provides the possibility to work with big data, which is important for all areas of human activity. The use of artificial intelligence systems to support management decision-making, to optimize the work, calculate efficiency with minimal human participation means making decisions based on learning from precedents, eliminating interventions that cause negative distortions. The advantage of artificial intelligence is that data are collected continuously and the emergence of big data increases the efficiency of the system, and those organizations that postpone the introduction of artificial intelligence systems into their operation risk to lag behind. At the present stage of development of the digital economy, the experience of applying intellectual information processing methods is of great value. It is a step in improving business efficiency based on the introduction of modern technologies, together with digital transformation tools [1].

The development of methods for intellectual processing of information is known to be based on the scientific works, the bibliography of which is given in [2-4].

Currently, one of the promising areas of development of modern technology is the creation of information support tools as a part of automated control and management systems.

These systems include telecommunications, data collection, processing and analysis systems, the most important feature of which is belonging to big data.

For a human being, the processing and understanding of data are one of the most complex and advanced functions of the brain. Owing to this, often systems of data collection and processing are limited to tasks, processing, analysis of which is carried out with human participation.

At the same time, in solving problems of decision-making support based on specific information, practical achievements are much more modest. In particular, there is some accumulated baggage in the form of a significant number of separate heuristic procedures for processing, analysis and recognition. Procedures such as standard operations are included (in a particular set) in data processing systems. The construction of a sequence of operations for the solution of specific tasks is carried out by highly skilled, experienced specialists in a largely intuitive way, and the solution of each new type of tasks requires carrying out all the work again. The result is that very often a rather large part of the data remains untreated and, accordingly, unclaimed by the end user. The latter circumstance is a significant drawback of the current situation, which determines the basic requirement for prospective approaches to solving applied data processing and recognition problems: the simplicity and reliability of the synthesis of high-quality complex procedures that do not require any creative work of specialists should be ensured.

So, the situation in the world can be characterized as follows: measurement tools are actively and successfully created and implemented; there are available means of computer technology of sufficient productivity; there is a significant theoretical reserve;in practice, traditional methods of data processing, analysis and recognition are applied, which cannot always provide support for decision-making in the problems at hand.

The most important feature of information processing problems that arise in various poorly formalized application areas is the absence of any adequate mathematical models for real situations or objects. On the basis of such models, it would be possible to make calculations and obtain quantitative or qualitative conclusions. These are data processing tasks that belong to a typical poorly formalized area.

The most important result can apparently be the justification for the possibility of solving various and poorly formalized problems on the basis of some general information principles without constructing adequate mathematical models of real processes or phenomena [2, 3].

The use of information processing tools is a new step in improving business efficiency by introducing modern technologies, including digital transformation tools. Systems of artificial intelligence allow you to operate with huge arrays of data, which is important for the financial sector.

Application of information technologies for making management decisions to optimize work with clients, for calculating the effectiveness of investments with minimal human participation means making decisions based only on information without human participation, which often has a negative imprint. The advantage of using artificial intelligence right now is that data collection is a continuous process and the larger the database gets, the more efficient the system works, therefore, those banks that ignore the implementation of artificial intelligence systems are lagging behind their competitors.

The aim is complex research of the problem of artificial intelligence systems application, the combination of real and simulated approaches on the basis of application of data processing and analysis methods. The use of artificial intelligence in business will lead to fundamental changes in customer service and a radical increase in business efficiency.

Constant complication of the modern business structure and the structured tasks it solves requires qualitatively new characteristics of algorithmic support that provide a high degree of data protection, a qualitatively new way of processing and analyzing data, and a quick search for relevant information. The processes of globalization of all spheres of society provide a high level of competition, the maintenance of which requires the use of powerful enterprise management systems, human resources and, consequently, improving the quality of work and the effectiveness of organizations [4].

The problems of credit risks [5-11]. Timely detection of possible bankruptcy signs allows management of credit institutions (hereinafter banks) to take prompt measures to remedy the financial condition and reduce the risk of bankruptcy.

A risk is the probability of a loss that could affect the performance of an economic entity or an economic transaction. Moreover, since the purpose of the bank's activities is to maximize profits, it must pay great attention to the implementation of its operations with the minimum possible risks. To avoid

bankruptcy, banks need to seek and apply effective methods and tools to manage these risks in order to achieve and maintain a stable position in the banking services market.

Numerous models for calculating credit risk evaluation of the borrower indicate the existence of problems in determining credit risk.

In modern banking practice, the problem of developing a computer system based on the ideas of the pattern recognition theory is urgent and allows the credit manager to determine the borrower's risk class and an estimate of the repayment of the loan and interest.

It allows to determine the borrower's risk class. Such a system can also be used in making various decisions in the course of monitoring real contracts - whether to conclude a contract, what measures to take in case of violations of the repayment schedule or interest payments, whether to prolong the contract, how to react to depreciation of collateral, etc.

Management of banking operations is essentially the management of risks associated with the bank portfolio, with a set of assets that provide the bank with income from its activities. The main part of the bank portfolio is loans to businesses and individuals, which is connected with a risk of full or partial loss of the bank's resources.

When developing the system, the following risk management algorithm was used:

1. Qualitative analysis - identification of the full range of risks, description of risks, analysis of initial assumptions, classification and grouping.

2. Quantitative analysis - formalization of uncertainty; calculation, assessment and accounting of risks.

3. Minimizing risks by designing risk management strategies, selecting the optimal strategy and implementing it.

4. Risk control - monitoring risks, reassessing and adjusting risks, as well as making operational decisions on deviations.

Risk management of the loan product is carried out at all stages of the life cycle of the risk evaluation system through monitoring and controlling actions in cases of deviation from the specified project parameters. Thus, the special nature of risk management as a stage of system design is to monitor continuously in dynamics and with adjustments in order to avoid deviations from the parameters specified by the bank because of exposure to risks in the process of participating in the system design cycle.

The main types of risk are liquidity risk, interest rate risk, risk of default on a loan.

The latter type of risk is especially important, since the non-return of borrowed funds brings large losses to banks and can serve as one of the reasons for bankruptcy.

The form, the amount of lending, the method of repaying the loan and the collateral requirements depend on the lending risk.

In this regard, the task of prompt and objective assessment of the lending risk is urgent.

The degree of risk of lending transactions is expressed in the highest interest rate for transactions that are of a credit nature (loans, guarantees) in comparison with other assets. Loan rates should compensate the bank for the value of the funds provided for the term, the risk of changing the value of collateral and the risk of the borrower failing to fulfill its obligations.

The risk of non-fulfillment of obligations by the borrower is determined by a large number of factors integrated into the concept of the client's creditworthiness.

The creditworthiness of a bank customer is its ability to fully and timely pay off on its obligations. Assessmentof the borrower’s creditworthiness, as the task of determining the financial stability of the borrower.It is important both at the stage of selection of potential borrowers, and at the stage of control over the course of the loan repayment.

When assessing creditworthiness, risk factors are taken into account:

1) the nature of the transaction being negotiated;

2) customer credit history;

3) the state of the industry and the region;

4) position of the client in the specified industry;

5) the financial condition of the client;

6) theability of the client to provide the property as collateral;

7) the social status of the client.

Analysis of credit risks is a complex task, including: developing methodological approaches to the analysis of a potential borrower; monitoring and analysis of changes in financial stability of a potential borrower, identification of unfavorable trends and their causes at the earliest possible stage.

To determine and analyze the risk, there are indicators for assessing the risk of lending. Given the multiplicity of risk indicators, the difference in the level of their critical assessments there is the need to evaluate existing techniques and determine how effective they are.

It should be noted that any indicator of the borrower's credit risk assessment may depend on a number of other indicators. Therefore, by introducing or ignoring any feature of the borrower for a more accurate forecast, we can simultaneously directly or indirectly change the effect of several indicators on the result. And it is not obvious that we will generally improve the final result of the forecast.

In addition, it must be taken into account that the effect of features on the result depends on the environment of the forecast, which, of course, is almost impossible to take into account.

Traditional models of risk assessment [5, 10]. Analysis of traditional models and methods of evaluating banking risks (such as the financial condition of the borrower, including the model of the borrower's classification by the point system, a two-factor model for assessing the probability of the bankruptcy of the borrower, assessing the probability of the borrower's bankruptcy based on the Altman Z-account, the model of Roman Lis for determining the financial state, the assessment of the borrower's financial position by U.Biver's indicators, the R-model of forecasting the risk of bankruptcy, Logit-method,etc.) makes it possible to identify the main shortcomings of such assessment approaches.

The reasons for this are in the following. First, these models provide an incomplete, one-sided assessment of the financial condition of the borrower, and therefore too large deviations of the forecast from reality are possible. Secondly, the models were developed for certain economic and political conditions. Thirdly, existing models of classification by the point system are usually developed conditionally and appropriate refinements are needed to apply them. Therefore, in order to obtain a more objective evaluation of the financial and economic state of the borrower, there is a need to create a more effective evaluation methodology.

Thus, an adequate mathematical model in the field of assessing banking risks has not been created yet, but the experience of heuristic solution of individual problems has been accumulated and, consequently, the use of precedent approach technology in solving recognition problems is possible.

The transition of banks to the valuation of capital on the basis of the borrowers' internal credit ratings has increased interest in the methods of risk assessment.

There is a known approach based on the application of the method of committees for building the borrowers' model of internal credit ratings. The method of committees allows to more accurately assess borrowers, than the more often used Logit-method. The main advantage of this method is the possibility of taking into account non-linear relationships of variables, whereas the Logit-method conceders only the linear dependence of the variables. It should be noted that one of the main problems of the committee method is the computational complexity (it took more than 10 hours only to construct the committee), whereas the construction of the Logit model takes several minutes. The model of internal ratings developed in this paper certainly does not satisfy all the requirements of Basel II, because it is based on data for a period of less than five years and has a low value of Accuracy Ratio, which is due to the lack of parameters. The model of internal ratings developed using the method of committees will be more accurate than the model with the application of the Logit-method, which will positively affect the quality of the credit organization's assessment of the risks being taken [11].

However, this approach has a number of limitations related to data diversity and computational complexity. The authors mention it in their work.

The paper proposes an approach that allows to take into account the limitations associated with data diversity and computational complexity.

In this connection, it is important to create methods, for example, by applying the precedent approach methods (search for a solution "by analogy") [2].

The application of such a method makes it possible to combine the possibility of selecting characteristics based on the existing experience of using features in similar systems, their description and explanation (argumentation) of the solution obtained on the basis of the mathematical theory of pattern recognition.

At the same time, it should be noted that there is no domestic software that automates the solution of the banking sector tasks, despite the fact that the use of information technologies and systems of this direction in other subject areas of knowledge makes it possible to significantly improve the efficiency of its solution process [2, 3].

As a methodological basis for the decision-making process, a "precedent" approach was proposed. In this case, the information of the credit bureau, including both data on the reasons for refusal to the client in the loan, and on the materials recommended for issuing loans and fulfilling the obligations of the borrower in the past, can additionally be used as precedents.

The purpose of this work is to improve the quality of decision making when determining the class of individual borrowers using recognition algorithms based on the calculation of estimates with the help of the proposed Intellectual Program Support System for Decision Making.

None of the decision rules can be recognized as universal and free of shortcomings that limit the scope of their application. Moreover, the creation of universal decision rules, apparently, is impossible in principle. This is due to the fact that, depending on the purposes, the system of preferences and the possibilities of obtaining information on preferences, various decision rules can be created.

The proposed model of risk assessment [2-5]. We propose a formalized approach that makes it possible to implement the decision-making process on the appropriateness of issuing a loan using pattern recognition techniques. The task of evaluating the financial condition is reduced to the classification of borrowers on the basis of sufficiently weak requirements for the initial data. Borrowers classified as belonging to the same class of patterns will have common properties, i.e.willhave approximately the same level of financial stability, creditworthiness, and be equal.

When solving the task of classifying a borrower, the expert determines the classes of risk assessment, characterized as a class of borrowers with a very high-risk probability, a class of borrowers with an average risk probability, a class of borrowers with a very low-risk probability. Borrowers who wish to take out a loan are referred to one of the previously defined classes, based on the level of their financial condition. Depending on the chosen risk class, the system determines which credit policy the manager shouldselect.

Substantial statement of the problem. State classes are defined, each of which contains borrowers with the same risk assessment. Each borrower is described by a set of features that characterize its state. It is required to put the defined borrower to one of the risk classes.

In the language of the mathematical theory of pattern recognition, this problem is defined as follows.

Formal setting of the problem. Input information is a set of vectors

$$X = \{x_j \,|\, j = 1, M\} \subset R^n, \text{ where } \quad x_j = (x_j^{(1)}, ..., x_j^{(n)}).$$

Here M – is the number of vectors n – is the number of characteristics, x_j – j-th is the vector (j-th observation).

The task of training with the teacher. Suppose that unknown q classes of objects $\overline{X}_1, \overline{X}_2, ..., \overline{X}_q$, that in a given set X (the training set) are represented by finite subsets

$$X_1, X_2, ..., X_q, \quad X = \bigcup_{i=1}^{q} X_i, \quad X_i \cap X_j = \Theta \quad \forall i \neq j.$$

It is necessary to create a rule by means of which it is possible to classify with a sufficient degree of reliability objects belonging to classes $X_1, X_2, ..., X_q$, but not contained in the training set X. The criterion for the quality of the sought-for decision rule is the percentage of correctly recognized objects with a priori known classification, but not participating in training. A set of such objects is called a check or validation sample. Forming a validation sample from the set of all the objects presented for training is also a very important task.

The recognition of an object is based on a previously conducted training - a stage that precedes the recognition phase. The aim of the training is to select such thresholds, which result in a minimum number

of errors on the training set of objects with the known membership of classes (training). The next stage after the training is the stage of training control. It consists in checking the training, calculating the error in recognizing objects of the examination set of objects that belong to known classes (the exam). In addition, the last stage is the recognition of an unknown object.

At present, a large number of algorithms for object recognition have been developed and extensive experience in solving applied problems in various fields of science and technology has been accumulated. The most developed and well-known model of recognition is the model of algorithms for calculating assessments. An algebraic theory of pattern recognition is created. Multiparametric algorithms of this model were used as the basis for the decision support system for determining the size of the loan.

The class of algorithms based on the calculation of assessments is given by describing the six elements defining it:

1. A system of reference sets,
2. Proximity function,
3. Calculation of estimates for the rows of a fixed reference set,
4. Calculation of the estimate for the class from the reference set,
5. An estimate for a class in the system of reference sets,
6. The decision rule.

Any recognition algorithm, the task of which consists of these six elements, will be an algorithm for calculating assessments, which are a set of all possible recognition algorithms that can be specified by the six elements under consideration.

Thus, we can say that by choosing a particular system of reference sets, defining the proximity function, specifying the rules for calculating assessments for the rows of a fixed reference set, for a class over a reference set and for a system of reference sets, also assigning a decision rule, we get some specific algorithm for computing assessments. The class of recognition algorithms based on the calculation of assessments includes all possible algorithms that can be created from the six elements considered.

Advantages of this model are as follows.

1. Presence of controllable model parameters;
2. Availability of training;
3. The analysis models are parametric;
4. Possibility of finding significant objects of classes;
5. Presence of weights of objects, features;
6. Considering diversified information;
7. Ability to select significant signs;
8. Assessment of expert breakdown of objects into classes;
9. Ability to identify borrowers who are in borderline areas.

Using this approach allows us to obtain a more accurate and objective result. This helps to reduce the risk of loss and make a profit, as well as to give reasons for the decisions made when working with lenders and partners.

The ultimate goal of the work is the construction of an experimental computer system for determining the risk of lending based on the borrower’s condition. For this purpose, the information system "Risk assessmentin retail lending" was developed, on the input of which the borrower's descriptions submitted by the vector-descriptions and divided by the expert into classes on risks are submitted. For a recognizable borrower, the system determines the class of its credit risk [3-6, 11].

Integrated software environment [12-14]. The system includes the following modules: a characteristics processing module, a training module, an examination module, a recognition module. In addition, the system includes a module for analyzing the borrower's risk based on a dynamic set of characteristics, a module for selecting significant characteristics, a module for selecting financially stable borrowers, a module for selecting the standards for each risk class, and a module for integrating dissimilar remote systems.

In our opinion, the model of internal ratings developed with the use of EA will be more accurate than the model with the application of the method of committees, which can improve the quality of the credit organization's assessment of the risks being taken.

As noted above, a number of characteristics in the assessment of the borrower is a dynamic set, which in turn depends on the external environment - from the review period, the methodology of assigning ratings by some agencies.

Conclusion. In this work, we touched on the issues of credit risks in banking operations and showed the possibility of using recognition algorithms based on the calculation of assessments in them.There are also other approaches to the definition of bank risks in the issuance of loans. We note that a lot of research has been devoted to the theoretical foundations of risk in multicriterion and gaming problems.

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ҚАРЫЗ АЛУШЫ ТОПТАРДЫ ТАҢДАУДЫ БАҒАЛАУ

Аннотация. Ақпараттарды интеллектуалдық өңдеу әдістерін қолдану заманауи технологияларды, оның ішінде цифрлік трансформация құралдарын енгізу арқылы бизнестің тиімділігін арттыруда жаңа қадам болып табылады. Ереже бойынша, нақты тапсырмаларды шешу бойынша операцияларды құрастыру рәсімдеусіз тәжірибелі мамандардың интуициялық көрсеткішінің негізінде орындалады және әрбір жаңа тапсырманы шешу қайтадан барлық жұмыстың орындалуын талап етеді. Соңында көбінесе деректердің көп бөлігі өңдеусіз және қажетсіз болып қала береді. Бұл ағымдағы жағдайдың маңызды кемшілігі болып табылады, ол деректерді өңдеудің қолданбалы тапсырмаларын шешуде келешегі бар әдістер үшін негізгі талаптарды анықтайды, мысалы, мамандардың интуициялық жұымысын талап етпейтін күрделі процедуралардың қарапайымдылығы мен сенімділігін қамтамасыз етуін талап етеді. Мақалада банктік операцияларда кредиттік тәуекелдердің мәселелері қарастырылады және прецедент әдісінің негізінде тану алгоритмділерін қолданудың артықшылықтары көрсетіледі. Бұл шығыс тәуекелін төмендетуге және кіріс алуға, сонымен қатар серіктестер мен қарыз алушыларен жұмыс істеу барысында шешімдерді негіздеуге мүмкіндік береді.

Дәстүрлі әдістердің маңыздылығын көрсете отырып, біз ұсынылып отырған әдістің нақты және объективті нәтиже алуға, үлкен көлемдегі деректермен жұмыс жасауға, клиенттерге қызмет көрсетуді оңтайландыруға, адамға ең аз әсер ететін инвестициялардың тиімділігін есептеуге мүмкіндік береді.

Түйін сөздер: шешім қабылдауды қолдау, прецеденттік тәсіл, көп критерийлі таңдау, алгоритмдік қамтамасыз ету, жасанды интеллект, банк, тиімділік, жаһандану, клиент, цифрландыру.

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ОЦЕНКА ВЫБОРА РЕЙТИНГОВЫХ ГРУПП ЗАЕМЩИКОВ

Аннотация. Применение методов интеллектуальной обработки информации является новым шагом в повышении эффективности бизнеса на основе внедрения современных технологий, в том числе инструментов цифровой трансформации. Как правило, построение операций по решению конкретных задач без формализации осуществляется опытными специалистами в значительной степени интуитивно, и решение каждой новой задачи требует всей работы заново. В результате часто довольно большая часть данных остается необработанной и невостребованной. Это является существенным недостатком текущей ситуации, которая определяет основное требование для перспективных подходов к решению прикладных задач обработки данных: должна быть обеспечена простота и надежность сложных процедур, не требующих интуитивной работы специалистов. В статье рассматриваются методические проблемы кредитных рисков в банковских операциях и показаны преимущества использования алгоритмов распознавания на основе вычисления оценок. Это помогает снизить риск потерь и получить прибыль, а также обосновать решения при работе с заемщиками и партнерами. Подчеркивая важность традиционных подходов, мы отмечаем, что

использование предлагаемого подхода позволяет получить более точный и объективный результат, работать с большими наборами данных, оптимизировать обслуживание клиентов, рассчитать эффективность инвестиций с минимальным воздействием на человека.

Ключевые слова: поддержка принятия решений; прецедентный подход; многокритериальный выбор; алгоритмическое обеспечение, искусственный интеллект, банк, эффективность, глобализация, клиент, цифровизация.

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