Credit fraud modeling is an important topic covered by researchers. Overdue risk management is a critical business link in providing credit loan services. It directly impacts the rate of return and the bad debt percentage of lending organizations in this sector. Credit financial services have benefited the general public as a result of the development of the mobile Internet, and overdue risk control has evolved from the manual judgment that relied on rules in the past to a credit model built using a large amount of customer data to predict the likelihood of customers becoming delinquent. When creating a credit rating model, the emerging nature of the credit samples makes the minority class sample score very few; that is, when a large number of actual samples are obtained, this causes machine learning models to be biased towards the majority class when training. Traditional data balancing methods can reduce the bias of models to the majority category when the data is relatively unbalanced rather than excessive. Gradient boosting algorithms (XGBoost and CatBoost) are proposed in this paper to model highly unbalanced data to detect credit fraud. To find hyperparameters and determine the accuracy of the minority class as an optimization function of the model, Bayesian optimization is used to increase the model’s accuracy for the minority class. The paper was tested with real European credit card fraud data. The results were compared to traditional machine learning (decision trees and logistic regression) and the performance of the bagging algorithm (random forest). For comparison, the traditional data balancing method (Oversample) is used.

**Keywords:** machine learning, credit fraud modeling, unbalanced data, gradient boosting algorithms.

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DEVELOPMENT OF INTELLIGENT AND EXPERT SYSTEM FOR AUTOMATION OF PROCESSES OF MINING AND TRANSPORT WORKS ON THE BASIS OF SATELLITE NAVIGATION (p. 13–26)

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The object of research relates to the field of control systems for mining and transport machines in the development of deposits of solid minerals in an open way. The problem of reducing the cost of transporting 1 ton of rock mass and increasing the efficiency of these machines is being solved. The article develops an expert system for dispatching mining vehicles with a subsystem for selecting their operational parameters, taking into account the stochastic conditions of the developed sections of the rock mass. The mathematical model for constructing the prospective appearance of a mining and transport machine, based on its functional and economic assessment, is reduced to solving the problem of optimizing the generalized criterion of the required efficiency. As an example of private indicators of their effectiveness in operation, there is an expert analysis of the evaluation of solution options, for example, structural-kinematic and operational parameters of these machines, etc. Innovative designs of a skip body of any size of its carrying capacity of single-rope and multi-rope steeply inclined skip hoists for highly profitable mining in quarries are substantiated. Unlimited values of their depth and annual productivity. In the proposed study, the values of the forces of resistance to the destruction of a section of a rock mass, obtained
by analytical and experimental methods, are refined by finding the optimal Kalman coefficient, which increases the efficiency of using mining and transport machines. The proposed methods provide the creation of innovative mining and transport machines with the ability to control their operational parameters, taking into account the stochastic conditions of the developed section of the rock mass.

**Keywords:** open pit mining, dispatching system, rock mass, skip hoist, counterweight.

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**BUILDING A MODEL FOR RESOLVING REFERENTIAL RELATIONS IN A MULTILINGUAL SYSTEM** (p. 27–33)

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This paper considers an approach to resolving referential relations when extracting information from a text. The proposed approach is an attempt to integrate the multifactorial model of the activation coefficient with the approach to resolving the referential ambiguity of the text when replenishing the ontology. The found objects are compared based on an assessment of the proximity of attributes and relationships of objects. An ontological interpretation of relations and measures of similarity of attributes based on a multifactorial model is proposed. This model is distinguished by the fact that it makes it possible to introduce the concepts of “rhetorical distance”, “linear distance”, “animation”, “distance between paragraphs”, and “syntactic and semantic role of the antecedent”. A multifactorial model is proposed, which is a necessary and sufficient component for the purpose of explaining the measure of similarity of referents for choosing the best applicant. The counting system and its modification were revealed by trial and error; the work was carried out until the selected numerical weights began to explain all the available material. The current study also examines the factors of choice of reference devices that make it possible to work with complex sentences and texts. Moreover, examples of finding a measure of proximity in a multilingual system for the Kazakh, Russian, and English languages are offered. For the current paper, texts in the Russian, English, and Kazakh languages were used as a source for practical tasks. The texts were selected using news articles on the Internet sites where translations into other languages, including those named above, were offered.

The authors of this study have done massive practical work, which confirms the correctness of the thesis they are considering.

Keywords: information extraction, proximity measure, referential factors, semantic text analysis, anaphora.

Abstract and References. Information technology, industry control systems

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This paper considers an approach to resolving referential relations when extracting information from a text. The proposed approach is an attempt to integrate the multifactorial model of the activation coefficient with the approach to resolving the referential ambiguity of the text when replenishing the ontology. The found objects are compared based on an assessment of the proximity of attributes and relationships of objects. An ontological interpretation of relations and measures of similarity of attributes based on a multifactorial model is proposed. This model is distinguished by the fact that it makes it possible to introduce the concepts of “rhetorical distance”, “linear distance”, “animation”, “distance between paragraphs”, and “syntactic and semantic role of the antecedent”. A multifactorial model is proposed, which is a necessary and sufficient component for the purpose of explaining the measure of similarity of referents for choosing the best applicant. The counting system and its modification were revealed by trial and error; the work was carried out until the selected numerical weights began to explain all the available material. The current study also examines the factors of choice of reference devices that make it possible to work with complex sentences and texts. Moreover, examples of finding a measure of proximity in a multilingual system for the Kazakh, Russian, and English languages are offered. For the current paper, texts in the Russian, English, and Kazakh languages were used as a source for practical tasks. The texts were selected using news articles on the Internet sites where translations into other languages, including those named above, were offered.

The authors of this study have done massive practical work, which confirms the correctness of the thesis they are considering.

Keywords: information extraction, proximity measure, referential factors, semantic text analysis, anaphora.

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The main goal of the work is to create the optimal emergency evacuation plan in general education institutions according to the schedule at a certain time. The work developed an information model of the evacuation system, taking into account the schedule of classes and classes. The methodology of the system approach, which ensures the compatibility of heterogeneous devices to find an operationally optimal evacuation plan in real time, was developed. A conceptual scheme of an evacuation system using heterogeneous sources of receiving and transmitting information about emergencies is proposed. Determined the input and output sources of receiving and transmitting information about the number of people in the building. Developed software for the rapid and most effective evacuation of people from the educational institution and can be used for other types of buildings.

The importance of this work is the creation of an integrated evacuation information system based on mathematical modeling of evacuation information systems.
multi-criteria optimization problem of flow distribution and design, construction technology receiving and transmitting data and information notification systems for the selected type of building, in order to adopt an operational evacuation plan.

The results of this paper allow the systematic organization of evacuation training, preparing resources so that in the event of an emergency it is possible to quickly respond and conduct the evacuation process to avoid major consequences. The use of information technology greatly increases the efficiency of evacuation systems, so the development of new integrated and intelligent info-communication approaches to solve the problem of evacuation is currently very relevant.

Keywords: evacuation, information modeling, software system design, data transfer, operational plan.

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DEVELOPMENT AND MODELING OF COMBINED COMPONENTS OF THE INFORMATION ENVIRONMENT (p. 51–60)

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The relevance of the study is due to the problem of forming the concept of the information environment from the point of view of management. The theoretical foundations for the construction and practical application of the information environment of educational institutions are given, a model of an individual educational trajectory is designed, and the methodology for modeling the information environment of educational institutions based on systems theory is described. This is important, since the information environment helps to improve the efficiency and quality of the educational process through the implementation of information technology capabilities. An individual educational trajectory is considered as a process of
making a decision by a student based on a system of individual values and personal meanings; contains a qualification model of a specialist in the world of professions and opportunities for the implementation of vital plans. The qualification model of a specialist includes a qualification portrait of a specialist, regulatory requirements – a set of linguistic assessments and a set of numerical assessments that meet the requirements of employers.

As a result of the study, a systematic approach was applied, which makes it possible to determine the limitations of the system's functioning, the procedure for planning activities and the system for stimulating elements of the organization. A detailed review of the main models of interaction between the elements of the organization is made: bureaucratic, democratic participation and parity compromise. The bureaucratic model is characterized by a clear hierarchy of rules and decisions, strict regulation of job descriptions. The model of democratic participation is focused on the development of creative abilities of an employee, when, performing a particular function, he expects to achieve personal goals, directing his efforts to achieve the goals of the organization.

The results of the study are aimed at an effective choice of interaction models depending on the main elements of systemic activities in educational institutions related to improving the quality of work and education.

**Keywords:** information environment, individual educational trajectory, system analysis, information technology.

**Abstract and References. Information technology.**

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**SELECTING A METHOD FOR THE PARAMETRIC ADAPTATION OF PI-CONTROLLER IN THE CONTROL SYSTEMS OF BOILER ASSEMBLIES AT THERMAL POWER STATIONS WITH SUPERCritical PARAMETERS (p. 61–68)**

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In the context of the growing share of renewable energy sources, the role of thermal power plants (TPPs) as means of balancing the daily power demand curve is increasing. During the day, the load on working units varies widely. Boiler assemblies of these power units undergo changes in their dynamic characteristics when the load changes. Control systems must, regardless of the mode of operation, meet requirements for the quality of operation. This paper has analyzed the latest research and advancements in the field of synthesis of adaptive and robust control systems for inertial contours
of direct-flow boiler assemblies. It reports a model of the section of a water-steam flow path, which takes into consideration changes in the dynamic characteristics of the section when changing the load of the power unit. A model of the temperature control system for a boiler assembly has been built involving a tabular method for adjusting the PI-controller parameters. Alternative methods for the adaptation of parameters were proposed. The resulting expressions demonstrate a piecewise-linear approximation of parameter changes depending on the load. In addition, an adaptation unit based on fuzzy logic was suggested. Static characteristics of the adaptation units for PI-controller parameters depending on the load of the power unit were defined. Based on computer modeling, a comparative analysis of the quality indicators of the functioning of the designed control systems was carried out. A method for estimating the stability of systems with adaptation of adjustment parameters was proposed. Based on the static characteristics of the pairs of settings of the PI-controller and the parameters of the control object for each load value at the predefined discreteness, stability reserves were calculated for gain and phase. The results reported here indicate the advantages of a control system with the adaptation of controller parameters based on piecewise-linear dependences.

Keywords: PI-controller, adaptation of parameters, tabular control, stability margin, fuzzy logic.

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DOI: 10.15587/1729-4061.2022.253886 IMPLEMENTATION OF REGRESSION ALGORITHMS FOR OIL RECOVERY PREDICTION (p. 69–75)

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This paper presents the work of predicting oil production using machine learning methods. As a machine learning method, a multiple linear regression algorithm with polynomial properties was implemented. Regression algorithms are suitable and workable methods for predicting oil production based on a data-driven approach. The synthetic dataset was obtained using the Buckley-Leverett mathematical model, which is used to calculate hydrodynamics and determine the saturation distribution in oil production problems. Various combinations of parameters of the oil production problem were chosen, where porosity, viscosity of the oil phase and absolute permeability of the rock were taken as input parameters for machine learning. And the value of the oil recovery factor was chosen as the output parameter. More than 400 thousand synthetic data were used to test multiple regression algorithms. To estimate the quality of regression algorithms, the mean square error metrics and the coefficient of determination were used. It was found that linear regression does not cover all patterns in the data due to underfitting. Various degrees of polynomial regression were deployed and tested, and it was also found that for our synthetic data, the quadratic polynomial model trains quite well and perfectly predicts the value of the oil recovery factor. To solve the overfitting problem, L1 regularization known as the Lasso regression method was applied. For the quadratic polynomial regression model, the coefficient of determination was 0.96, which is a pretty good result for the test data. Thus, it is assumed that the data-driven machine learning methods discussed in the paper can be useful for predicting the oil recovery factor using practical data from oil fields at the stages of production.

**Keywords:** machine learning, polynomial regression method, enhanced oil recovery, lasso regularization.

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Моделювання кредитного шахрайства є важливою темою, що зачиняється дослідниками. У наданні кредитних послуг найважливішою ланкою є управління ризиками простроченої заборгованості. Це безпосередньо впливає на норму прибутковості та відсоток безпідрозділової заборгованості кредитних організацій у даному секторі. Кредитні фінансові послуги приносять користь широкій громадськості в результаті розвитку мобільного інтернету, а управління ризиками простроченої заборгованості передбачає застосування різних інструментів, зокрема зміну засновованих на правах, у кредитну модель, побудовану з використанням великого обсягу даних про клієнта для прогнозування ймовірності їхньої неплатоспроможності. При створенні моделі кредитного ризику використовано усі різних кредитних вибірків зменшується оцінка вибірки якісності, тобто, отримання великої кількості фактичних вибірків призводить до зміщення моделей машинного навчання в бік класу якісності при навчанні. Традиційні методи балансування даних можуть зменшити зміщення моделей до категорії більшості, коли дані відносять незбалансовані, а не надлишкові. Для виявлення шахрайства з кредитами у роботі пропонується алгоритми виправлення градієнта (XGBoost та CatBoost) для моделювання сильно незбалансованих даних. Для знаходження гіперпараметрів та визначення точності класу якості моделі використовується байесівська оптимізація для підвищення точності моделі для класу якості. Дослідження було переведено на реальні дані про шахрайство з кредитними картками у Європі. Результати були зіставлені з традиційним машинним навчанням (дерево прийняття рішень та логістична регресія) і ефективністю алгоритму беттінга (випадковий ліс). Для порівняння використовується традиційний метод балансування (передискретизація).

**Ключові слова:** машинне навчання, моделювання кредитного шахрайства, незбалансовані дані, алгоритми виправлення градієнта.
Динамічні характеристики котлоагрегатів навчальних енергоблоків впливають на ефективність планування діяльності в освітніх установах, особливо при досягненні цілей, направляючи свої зусилля на досягнення цілей організації.

Результати дослідження зумовлена задачею формування концепції інформаційного середовища з точки зору управління. Наведено теоретичні основи побудови та практичного застосування інформаційного середовища освітніх закладів, розроблено модель індивідуальної освітньої траєкторії, описана методика моделювання інформаційного середовища освітніх закладів на основі теорії систем. Це має велике значення, оскільки інформаційне середовище сприяє підвищенню ефективності та якості освітнього процесу за рахунок реалізації можливостей інформаційних технологій.

Індивідуальна освітня траєкторія розглядається як процес прийняття студентом рішень на основі системи індивідуальних цінностей та особистісних смислів. Освітня діяльність в умовах конкретного середовища впливає на формування особистості відповідно до змін інтересів та потреб. Контекстута освітої траєкторії включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів. Кваліфікаційна модель фахівця включає в себе кваліфікаційний портрет студента, нормативні вимоги, світові професії та можливості для реалізації життєвих планів.

Для розроблення інформаційної моделі системи евакуації з урахуванням розкладу у певний час, використання математичного моделювання може бути використане для інших типів будівель.

Результати дослідження був застосований системний підхід, що дозволяє визначати обмеження функціонування системи, порядок планування діяльності та систему стимулювання елементів організації. Зроблено детальний огляд основних моделей взаємодії між елементами організації: бюрократична, демократична участь та паритетний компроміс. Бюрократична модель характеризується чіткою ієрархією правил та рішень, суворою регламентацією посадових інструкцій. Модель демократичної участі впливає на порядок планування діяльності та систему стимулювання елементів організації.
параметрів залежно від навантаження. Також запропонований блок адаптації на основі нечіткої логіки. Побудовані статичні характеристики блоків адаптації параметрів ПІ-регулятора в залежності від навантаження енергоблоку. На основі комп’ютерного моделювання проведені порівняльний аналіз показників якості функціонування розроблених систем керування. Запропоновано метод оцінки стійкості систем з адаптацією параметрів регулювання. На основі статичних характеристик пар налаштованих ПІ-регулятора і параметрів об’єкта керування для кожного значення навантаження з заданою дискретністю розраховані запаси стійкості за підсиленням і за фазою. Отримані результати свідчать про переваги системи регулювання з адаптацією параметрів регулятора на основі кусково-лінійних залежностей.

Ключові слова: ПІ-регулятор, адаптація параметрів, табличне керування, запас стійкості, нечітка логіка.

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ВИКОРИСТАННЯ АЛГОРИТМІВ РЕГРЕСІЇ ДЛЯ ПРОГНОЗУВАННЯ ВИДОБУТКУ НАФТИ (с. 69–75)

Yerzhan Kenzhebek, Timur Imankulov, Darkhan Akhmed-Zaki, Beimbet Daribayev

У даній статті представлена робота з прогнозування видобутку нафти з використанням методів машинного навчання. В якості методу машинного навчання був використаний алгоритм множинної лінійної регресії з поліноміальними властивостями. Алгоритми регресії є зручними та дієвими методами прогнозування видобутку нафти за допомогою підходу на основі даних. Отримано синтетичний набір даних з використанням математичної моделі Баклі-Леверетта, яка використовується для розрахунку гідродинаміки та визначення розподілу насиченості у задачах нафтовидобутку. Були обрані різні комбінації параметрів задачі нафтовидобутку, де в якості вхідних параметрів для машинного навчання були взято пористість, в’язкість нафтової фази та абсолютна проникність породи, а в якості вихідного параметра було вибрано значення коефіцієнта вилучення нафти. Для тестування алгоритмів множинної регресії було використано понад 400 тисяч синтетичних даних. Для оцінки якості алгоритмів регресії використовувалися показники середньоквадратичної помилки і коефіцієнт детермінації. Було виявлено, що через недонавчання лінійна регресія не охоплює всі закономірності в даних. Було розгорнуто і протестовано різні ступені поліноміальної регресії, а також було виявлено, що для наших синтетичних даних модель квадратичної полінома досить добре навчається і відмінно прогнозує значення коефіцієнта вилучення нафти. Для вирішення проблеми перенавчання була застосована L1-регуляризація, відома як метод регресії лассо. Для моделі квадратичної поліноміальної регресії коефіцієнт детермінації склав 0,96, що є досить хорошим результатом для тестових даних. Таким чином, передбачається, що розглянуті в роботі методи машинного навчання на основі даних можуть бути корисними для прогнозування коефіцієнта вилучення нафти з використанням практичних даних по нафтовим родовищам на етапах видобутку.

Ключові слова: машинне навчання, метод поліноміальної регресії, підвищення нафтовіддачі, регуляризація лассо.