

№	Статья и ссылка	Аннотация
1	Alpar , S., Tokmukhamedova, F., Alipova, B. ., Daineko , Y. ., Rysbek, N., & Abdrakhman, D. . (2024). MODELING OF BLOOD FLOW IN LAMINAR MODE. <i>Scientific Journal of Astana IT University</i> , 19, 5–15. https://doi.org/10.37943/19QEOK8161	This article presents a detailed analytical evaluation and comprehensive description of a mathematical model designed to simulate blood flow within the human cardiovascular system. The primary objective of this research is to develop a computational model capable of accurately simulating blood flow dynamics and to assess the variations in results using different numerical methods for solving the Navier-Stokes equations, which govern fluid motion. To achieve this, the study begins with an in-depth examination of the anatomy of the cardiovascular system, including various cardiovascular diseases such as stenosis and atherosclerosis, which significantly affect blood flow. The model incorporates important characteristics of blood, treating it as a viscous fluid under laminar flow conditions. Using the Navier-Stokes equations, it was developed a Python-based model to simulate these flow conditions and solve for different flow variables, such as velocity and pressure fields, under both normal and pathological conditions. The computational model was developed using two numerical methods: the Euler method and the Alternating Direction Implicit (ADI) method, which were compared in terms of their computational efficiency and accuracy. The simulations generated insights into how plaque buildup (stenosis) affects blood flow by altering wall shear stress and velocity profiles. This model, while built on foundational fluid dynamics principles, serves as an essential step towards creating a virtual reality (VR) surgical simulator for cardiovascular procedures. This simulator aims to assist surgeons in visualizing and planning surgical interventions by providing an interactive and realistic environment for studying blood flow and related complications. Keywords: blood flow modeling, blood hydrodynamics, alternating direction implicit method, modeling of cardiovascular diseases
2	Adamova, A., & Zhukabayeva , T. . (2024). DEVELOPMENT OF A METHODOLOGY FOR DATA	The number of interacting devices is increasing every day, and with this constant innovation, serious security challenges arise. The concept

	NORMALISATION AND AGGREGATION TO ENHANCE SECURITY LEVELS IN INTERNET OF THINGS INTERACTIONS. <i>Scientific Journal of Astana IT University</i>, 19, 16–27. https://doi.org/10.37943/19UQOC7381	of the Internet of Things is being actively applied in both domestic and industrial settings. Researchers are increasingly highlighting the challenges and importance of network security. Data preprocessing plays an important role in security by transforming the input data corresponding to algorithmic criteria and thereby contributing to the prediction accuracy. The data preprocessing process is determined by many factors, including the processing algorithm, the data, and the application. Moreover, in Internet of Things interactions, data normalisation and aggregation can significantly improve security and reduce the amount of data used further decision making. This paper discusses the challenges of data normalisation and aggregation in the IoT to handle large amounts of data generated by multiple connected IoT devices. A secure data normalisation and aggregation method promotes successful minimised data transfer over the network and provides scalability to meet the increasing demands of IoT deployment. The proposed work presents approaches used in data aggregation protocols that address interference, fault tolerance, security and mobility issues. A local aggregation approach using the run-length encoding algorithm is presented. The proposed technique consists of data acquisition, data preprocessing, data normalisation and data aggregation steps. Data normalisation was performed via the Z-score algorithm, and the LEACH algorithm was used for data aggregation. In the experimental study, the percentage of faulty nodes reached 35%. The performance of the proposed solution was 0.82. The results demonstrate a reduction in resource consumption while maintaining the value and integrity of the data. Keywords: Internet of Things, security, data normalisation, data aggregation, z-score, LEACH
3	Medetov , B., Zhetpisbayeva , A., Serikov , T., Khamzina, B., Yskak , A., & Zhexebay , D. (2024). IMPLEMENTATION OF NATURAL EXPERIMENTS IN PHYSICS USING COMPUTER VISION. <i>Scientific Journal of Astana IT University</i>, 19, 28–	Laboratory experiments in physics are a fundamental basis for studying physical phenomena occurring in nature and a methodological tool that provides visibility of the learning process and conducting experiments is important for the formation of students’ scientific worldview, deep understanding of physical laws and increasing

45.
<https://doi.org/10.37943/19RSGA5438>

interest in the study of physics. Existing in universities and schools, in addition to traditional ones, modern tools, technologies and approaches, such as virtual reality, augmented reality, computer modelling, online laboratories, virtual laboratory and others, are additional tools for improving the quality of the learning process and teaching techniques, which do not replace full-scale experiments, but only supplement them. In our opinion, for better learning, laboratory installations in physics are needed, with the help of which students can carry out real-life experiments and can broadcast them using innovative computer technologies for distance learning. To implement this task, we reviewed and analysed existing laboratory installations, identified their advantages and disadvantages, and then designed and developed alternative digital experimental set-ups for studying physics phenomena in laboratory conditions of educational institutions based on computer vision technology and presented the results of the study in this article. In carrying out the research tasks, effective methods of conducting scientific research were used, such as theoretical substantiation of the issue, experimental testing of the developed hardware and software systems and computer final processing of experimental data. In summary, the research described in the paper presents an innovative mechanism for integrating object tracking based on computer vision to improve the quality of measurements and new ways of conducting physics experiments. The mechanical laboratory complexes we have developed consist of hardware and software parts. The software part consists of server and client parts. The hardware consists of the main part - the scene, where the physical process takes place, i.e. where a physical object is located, such as a mathematical pendulum, an inclined plane, etc., with the help of which many physical phenomena and processes in mechanics can be demonstrated, and an additional part where a microcomputer and a camera are located. The operating principle of the laboratory installation is based on the use of computer vision technology, i.e. a system for monitoring the ongoing physical process, consisting of a digital camera for image processing, object identification and data

		export, and a microcomputer for processing experimental data. The use of the experimental installations in the process of teaching physics is a new model of teaching with a promising future in secondary and higher education, and the installations themselves will become tools for offline and online learning, due to the use of computer vision technology, revealing new opportunities and approaches to teaching. Keywords: physical experiment, laboratory installation, computer vision, secondary education, higher education, information and communication technologies, computer technologies
4	Boranbayeva , N. ., Orazbayev, B. ., Rzayeva, L., Karabayev, Z. ., Alibek, M. ., & Assanova, B. . (2024). FORECASTING AND OPTIMIZATION OF CATALYTIC CRACKING UNIT OPERATION UNDER CONDITIONS OF FUZZY INFORMATION. <i>Scientific Journal of Astana IT University</i>, 19, 46–59. https://doi.org/10.37943/19ICLE1807	This paper discusses the application of nonlinear regression to forecast and optimize the operation of catalytic cracking units under conditions of fuzzy information. Catalytic cracking is a crucial process in oil refining that produces high-quality gasoline and other light hydrocarbon products. However, the complexity of the process and the uncertainty of initial data complicate the modeling and optimization of plant operations. To address this issue, a nonlinear regression method is proposed that accommodates the fuzziness of input and output parameters described by linguistic variables. The methodology includes the collection and formalization of expert knowledge, the construction of fuzzy models, and their integration into the process control system. Forecasting is performed by creating regression models that describe the relationships between operational parameters and product quality characteristics. The paper presents a procedure for developing and applying nonlinear regression models, describes algorithms for synthesizing linguistic models, and provides examples of their use to optimize the operation of catalytic cracking units. The modeling results demonstrate the high adequacy and accuracy of the proposed method, as well as its advantages over traditional approaches in conditions of uncertainty and data scarcity. The scientific novelty of the research lies in the development and testing of advanced nonlinear regression models adapted for analyzing and optimizing catalytic cracking processes based on fuzzy data. These methods take into account the specificity and uncertainty of process data,

		improving the accuracy and reliability of forecasts, which facilitates more effective management of production processes in the petrochemical industry. The main reason for conducting this study is the need to improve the control of oil refining processes, particularly catalytic cracking, which plays an important role in producing high-quality gasoline. The complexity of this process and the presence of fuzzy information caused by fuzzy initial data require the development of new modeling and optimization methods. Existing traditional models based on deterministic methods are often insufficient under uncertainty. This leads to a decrease in the accuracy of process control, which can negatively affect the quality of the final product and production efficiency. The use of nonlinear regression in combination with fuzzy logic is a more flexible and adaptive approach that allows you to take into account the fuzziness and uncertainty of data and use expert knowledge to build models that match the actual operating conditions of the units. Thus, this study aims to solve the key problems associated with data uncertainty and the complexity of the catalytic cracking process, which will improve the accuracy of forecasting and optimization of the units. The main contribution is creating a model that uses nonlinear regression methods in combination with fuzzy logic. This allows uncertainty in input data (such as reactor temperature or pressure) to be effectively considered and processed to improve gasoline and other product yield forecasts. It is shown that using nonlinear regression combined with fuzzy logic significantly improves the management of technological processes, increases the output and quality of products, and reduces production costs. The conclusion of the paper discusses the prospects for further development of the methodology and its application to solve similar tasks in other areas of chemical technology. Keywords: catalytic cracing, nonlinear regression, fuzzy logic, optimization, forecasting, technological processes, oil refining
5	Utebayeva, D., & Ilipbayeva , L. . (2024). INVESTIGATION OF DEEP LEARNING MODELS BASED ON	In recent years, the potential risks posed by easily moving objects have highlighted the need for intelligent surveillance systems in

	SINGLE-LAYER SimpleRNN, LSTM AND GRU NETWORKS FOR RECOGNIZING SOUNDS OF UAV DISTANCES .<i>Scientific Journal of Astana IT University</i>, 19, 60–75. https://doi.org/10.37943/19XNOV6347	protected areas, primarily to ensure the safety of human lives. Among the most common of these objects are unmanned aerial vehicles (UAVs). Recent advances in deep learning techniques for recognizing audio signals have made these techniques effective in identifying moving or aerial objects, especially those powered by engines. And the growing deployment of UAVs has made their rapid recognition in various suspicious or unauthorized circumstances critical. Detecting suspicious drone flights, especially in restricted areas, remains a significant research challenge. It is vital to perform the task of determining their distance in order to quickly detect drones approaching people in such protected areas. Therefore, this paper aims to study the research question of recognizing UAV audio data from different distances. That is, recognizing drone audio at different distances was experimentally studied using Simple RNN, LSTM and GRU based deep learning models. The main objective of this study is based on finding one of the capable types of recurrent network for the task of recognizing UAV audio data at different distances. During the experimental study, the recognition abilities of Single-layer Simple RNN, LSTM and GRU recurrent network types were studied from two basic directions: with recognition accuracy curves and classification reports. As a result, LSTM and GRU based models showed high recognition ability for these types of audio signals. It was noted that UAVs can reliably predict distances greater than 10 meters based on the proposed deep learning architecture. Keywords: UAVs, UAV states, UAV sound recognition, UAV sound distance recognition, suspicious drone, SimpleRNN network, LSTM network, GRU network
6	Toxanov, S., Abzhanova, D., Neftissov, A. ., & Biloshchytskyi, A. (2024). METHODS OF FORECASTING GRAIN CROP YIELD INDICATORS TAKING INTO ACCOUNT THE INFLUENCE OF METEOROLOGICAL CONDITIONS IN THE INFORMATION-ANALYTICAL SUBSYSTEM. <i>Scientific Journal of</i>	Forecasting crop yields is one of the key challenges for the agricultural sector, especially in the context of a changing climate and unstable weather conditions. Kazakhstan, possessing significant territories suitable for growing grain crops, faces many challenges related to the effective management of agricultural activities. In this regard, yield forecasting becomes an integral part of planning and decision-making processes in

agriculture. Information and analytical subsystems that integrate yield forecasting methods allow agribusinesses to estimate future production more accurately, minimise risks associated with climate change and optimise resource use. An important component of such systems is the consideration of weather conditions, as weather factors have a direct impact on crop growth and development. The purpose of this article is to develop and evaluate modern methods of forecasting grain yields taking into account the influence of weather conditions, as well as their integration into information-analytical subsystems to improve the accuracy of agricultural forecasting. To achieve this goal, the article addresses the following tasks: to analyse existing methods of yield forecasting and identify their advantages and disadvantages, to develop forecasting models, including machine learning methods such as gradient boosting and recurrent neural networks, to validate the developed models on the basis of historical data using cross-validation methods, to evaluate the effectiveness of the proposed methods and compare them with basic models such as linear regression and simple average, to evaluate the effectiveness of the proposed methods and to compare them with the basic models such as linear regression and simple average. This article reviews modern methods of forecasting grain crop yields in Kazakhstan, as well as technologies used in information-analytical subsystems. Particular attention is paid to the analysis of the influence of meteorological conditions on yields and the development of models that take this factor into account. The presented review and research results are aimed at improving the existing approaches to the management of agricultural processes under conditions of growing uncertainty caused by climate change. The article explores an important scientific task related to the development of methods for step-by-step forecasting of agrometeorological factors and grain yields, relying on the principle of analogy.

Keywords:

forecasting, grain crops, meteorological conditions, Kazakhstan, agricultural technologies, climate, forecasting algorithms, agrarian activity management

7	Tleubayeva, A., & Shomanov, A. (2024). COMPARATIVE ANALYSIS OF MULTILINGUAL QA MODELS AND THEIR ADAPTATION TO THE KAZAKH LANGUAGE. <i>Scientific Journal of Astana IT University</i>, 19, 89–97. https://doi.org/10.37943/19WHRK2878	This paper presents a comparative analysis of large pretrained multilingual models for question-answering (QA) systems, with a specific focus on their adaptation to the Kazakh language. The study evaluates models including mBERT, XLM-R, mT5, AYA, and GPT, which were tested on QA tasks using the Kazakh sKQuAD dataset. To enhance model performance, fine-tuning strategies such as adapter modules, data augmentation techniques (back-translation, paraphrasing), and hyperparameter optimization were applied. Specific adjustments to learning rates, batch sizes, and training epochs were made to boost accuracy and stability. Among the models tested, mT5 achieved the highest F1 score of 75.72%, showcasing robust generalization across diverse QA tasks. GPT-4-turbo closely followed with an F1 score of 73.33%, effectively managing complex Kazakh QA scenarios. In contrast, native Kazakh models like Kaz-RoBERTa showed improvements through fine-tuning but continued to lag behind larger multilingual models, underlining the need for additional Kazakh-specific training data and further architectural enhancements. Kazakh's agglutinative morphology and the scarcity of high-quality training data present significant challenges for model adaptation. Adapter modules helped mitigate computational costs, allowing efficient fine-tuning in resource-constrained environments without significant performance loss. Data augmentation techniques, such as back-translation and paraphrasing, were instrumental in enriching the dataset, thereby enhancing model adaptability and robustness. This study underscores the importance of advanced fine-tuning and data augmentation strategies for QA systems tailored to low-resource languages like Kazakh. By addressing these challenges, this research aims to make AI technologies more inclusive and accessible, offering practical insights for improving natural language processing (NLP) capabilities in underrepresented languages. Ultimately, these findings contribute to bridging the gap between high-resource and low-resource language models, fostering a more equitable distribution of AI solutions across diverse linguistic contexts.
---	--	---

		Keywords: Multilingual models, NLP, Kazakh language, mBERT, XLM-R, mT5, GPT, AYA, question-answering, low-resource languages
8	Sarsenova, Z. ., Yedilkhan, . D. ., Yermekov, A. ., Salesnova, S. ., & Amirgaliyev, . B. . (2024). ANALYSIS AND ASSESSMENT OF AIR QUALITY IN ASTANA: COMPARISON OF POLLUTANT LEVELS AND THEIR IMPACT ON HEALTH. <i>Scientific Journal of Astana IT University</i> , 19, 98–117. https://doi.org/10.37943/19SZFA3931	This study presents an in-depth analysis of air quality in Astana, Kazakhstan, utilizing both mobile and stationary air monitoring systems over a two-year period. The research focuses on tracking key air pollutants, namely carbon monoxide (CO), nitrogen dioxide (NO₂), particulate matter (PM_{2.5} and PM₁₀), and sulfur dioxide (SO₂), providing a comparative assessment of seasonal trends and the sources of pollution, which include transportation, industrial emissions, and domestic heating during the cold season. The study emphasizes the significance of monitoring systems in urban environments to understand better the impact of air pollution on public health and the effectiveness of sustainable interventions. One of the major insights from this research is the comparison between seasonal variations in pollutant levels and the city's transition toward sustainable energy practices, such as increased gasification and the use of electric transportation, which has already demonstrated a positive impact on reducing emissions during peak heating periods. The results show that while Astana has improved air quality, air pollution remains a concern, especially in winter due to the increased use of solid fuel. This paper emphasizes the importance of real-time data from mobile sensors and suggests their wider use to complement stationary sensors for better monitoring. In addition to pollutant tracking, the study delves into the health implications of prolonged exposure to air pollutants, particularly in urban areas. The study concludes by advocating for expanded use of mobile monitoring systems and advanced data analytics to provide actionable insights for policymakers, urban planners, and public health officials. Keywords: Air pollution, Data Analysis, Air Quality, Air Monitoring, Smart City, Health Impact
9	Alzhanov, A., & Nugumanova, A. (2024). HIGH-RESOLUTION SATELLITE ESTIMATION OF SNOW COVER FOR FLOOD ANALYSIS IN EAST KAZAKHSTAN REGION	The increasing frequency of extreme weather events linked to climate change has made flood forecasting an important issue, particularly in mountainous regions where snowmelt is a major driver of seasonal flooding. This study

	<i>.Scientific Journal of Astana IT University, 19,</i> 118–127. https://doi.org/10.37943/19VUAO6399	explores the application of snow cover estimation techniques to assess snowmelt dynamics and their potential impact on flood risks in the Ulba and Uba basins in East Kazakhstan. To achieve this, high-resolution multispectral satellite imagery from the Sentinel-2 Surface Reflectance dataset is used, focusing on images collected between March and October for the years 2021 to 2024. The images are processed in Google Earth engine platform with strict filtering based on spatial intersection with the basins and cloud cover pixels percentage, ensuring high-quality data for snow cover analysis. The study utilizes multiple remote sensing indices for snow cover estimation. The normalized difference snow index is calculated using the green and shortwave infrared bands to detect snow-covered pixels. Fractional snow-covered area is derived from the NDSI using the 'FRA6T' relationship, offering a more nuanced estimate of snow distribution across the basins. Additionally, a near-infrared to shortwave infrared ratio threshold is employed to minimize confusion between snow and water, improving the detection of snow cover, particularly in regions near water bodies or during melt periods. The resulting snow cover maps and fSCA estimates provide a detailed picture of snow distribution and melt dynamics, contributing to the assessment of snowmelt's role in flood risk development. The obtained insights can assist in refining flood forecasting models, improving early warning systems, and supporting informed water resource management in vulnerable regions. Keywords: Remote sensing, satellite imagery, flood forecasting, snow cover
10	Diveev, A. ., Konyrbaev , N. ., Baishemirov, Z. ., Galymzhankyzy, A. ., & Abdullayev, O. . (2024). CONTROL SYSTEMS SYNTHESIS FOR ROBOTS ON THE BASE OF MACHINE LEARNING BY SYMBOLIC REGRESSION. <i>Scientific Journal of Astana IT University, 19,</i> 128–139. https://doi.org/10.37943/19OXFC5347	This paper presents a novel numerical method for solving the control system synthesis problem through the application of machine learning techniques, with a particular focus on symbolic regression. Symbolic regression is used to automate the development of control systems by constructing mathematical expressions that describe control functions based on system data. Unlike traditional methods, which often require manual programming and tuning, this approach leverages machine learning to discover optimal

		control solutions. The paper introduces a general framework for machine learning in control system design, with an emphasis on the use of evolutionary algorithms to optimize the generated control functions. The key contribution of this research lies in the development of an algorithm based on the principle of small variations in the baseline solution. This approach significantly enhances the efficiency of discovering optimal control functions by systematically exploring the solution space with minimal adjustments. The method allows for the automatic generation of control laws, reducing the need for manual coding, which is especially beneficial in the context of complex control systems, such as robotics. To demonstrate the applicability of the method, the research applies symbolic regression to the control synthesis of a mobile robot. The results of this case study show that symbolic regression can effectively automate the process of generating control functions, significantly reducing development time while improving accuracy. However, the paper also acknowledges certain limitations, including the computational demands required for symbolic regression and the challenges associated with real-time implementation in highly dynamic environments. These issues represent important areas for future research, where further optimization and hybrid approaches may enhance the method's practicality and scalability in real-world applications. Keywords: control synthesis, machine learning control, symbolic regression, evolutionary algorithm
11	Rakhymbek, K., Zhomartkan, N., Nurekenov, D., & Zhantassova, Z. (2024). FLOOD RISK MAPPING IN THE IRTYSH RIVER BASIN USING SATELLITE DATA. <i>Scientific Journal of Astana IT University</i>, 19, 140–149. https://doi.org/10.37943/19LRYW4856	Floods are among the most frequent and devastating natural disasters, causing significant economic damage and loss of life worldwide. Effective flood risk management relies on accurate modeling techniques that can predict vulnerable areas and assess potential impacts. In this study, flood dynamics are simulated in the Irtysh River Basin near Ust-Kamenogorsk, a city in East Kazakhstan prone to seasonal flooding using high-resolution satellite imagery and digital elevation data. The primary objective is to visually model flood risks based on terrain characteristics. The study utilizes imagery sourced from the Mapbox platform, which combines data from MODIS,

		Landsat 7, Maxar, and the Google Earth Engine, providing access to Sentinel-2 surface reflectance imagery at 10-meter resolution. Elevation data from the Copernicus global digital elevation model, with a 30-meter resolution, is used to simulate flood progression. The flood simulation involves calculating flood depth relative to the terrain's elevation, allowing for a pixel-by-pixel determination of submerged areas. Each simulation incrementally increases water levels to generate a sequence of images, showcasing the progression of flooding over time. The study describes hydraulic soil characteristics usage, and focuses on visualizing flood risk based on terrain data and water level changes. The simulation results indicate that flooding initially impacts riverbanks as water flow starts from the northwest of the city with critical infrastructure becoming vulnerable once water levels exceed 2 meters from the lowest elevation point. These findings highlight the potential of high-resolution satellite imagery and terrain data for flood risk assessment and improving urban flood preparedness. The results provide valuable insights into flood progression enabling more informed decision-making for disaster mitigation. Keywords: Flood map, Python, Mapbox, Google Earth Engine, Digital Elevation Models
12	Telmanov, M., Abdiakhmetova , Z. ., & Kartbayev, A. . (2024). OPTIMIZING PROCESSOR WORKLOADS AND SYSTEM EFFICIENCY THROUGH GAME-THEORETIC MODELS IN DISTRIBUTED SYSTEMS . <i>Scientific Journal of Astana IT University</i>, 19, 150–162. https://doi.org/10.37943/19GBUY8720	The primary goal of this research is to examine how different strategic behaviors adopted by processors affect the workload management and overall efficiency of the system. Specifically, the study focuses on the attainment of a pure strategy Nash Equilibrium and explores its implications on system performance. In this context, Nash Equilibrium is considered as a state where no player has anything to gain by changing only their own strategy unilaterally, suggesting a stable, yet not necessarily optimal, configuration under strategic interactions. The paper rigorously develops a formal mathematical model and employs extensive simulations to validate the theoretical findings, thus ensuring the reliability of the proposed model. Additionally, adaptive algorithms for dynamic task allocation are proposed, aimed at enhancing system flexibility and efficiency in real-time

		processing environments. Key results from this study highlight that while Nash Equilibrium fosters stability within the system, the adoption of optimal cooperative strategies significantly improves operational efficiency and minimizes transaction costs. These findings are illustrated through detailed 3D plots and tabulated results, which provide a detailed examination of how strategic decisions influence system performance under varying conditions, such as fluctuating system loads and migration costs. The analysis also examines the balance between individual processor job satisfaction and overall system performance, highlighting the effect of rigid task reallocation frameworks. Through this study, the paper not only improves our understanding of strategic interactions within computational systems but also provides key ideas that could guide the development of more efficient computational frameworks for various applications. Keywords: Game Theory, Nash Equilibria, processor optimization, distributed systems, strategic behavior, simulation algorithm, probabilistic approach
13	Biloshchytskyi, A., Kuchanskyi , O. ., Neftissov, A. ., Biloshchytska , S. ., & Medetbek, A. . (2024). INTEGRATED MODEL FOR FORECASTING TIME SERIES OF ENVIRONMENTAL POLLUTION PARAMETERS. <i>Scientific Journal of Astana IT University</i>, 19, 163–178. https://doi.org/10.37943/19IKWT5637	The quality of life in large urban areas is considerably diminished by air pollution, with major contributors being motor vehicles, industrial activities, and fossil fuel combustion. A major contributor to air pollution is coal-fired and thermal power plants, which are commonly found in emerging markets. In Astana, Kazakhstan, a rapidly expanding city's significant reliance on coal for heating and considerable building exacerbate air pollution. This research is essential for improving urban development practices that support sustainable growth in rapidly expanding cities. Using time series data from four monitoring stations in Astana using fractal R/S analysis, the study looks at long-term patterns in air pollutant levels, especially PM10 and PM2.5. The stations' Hurst exponents were determined to be 0.723, 0.548, 0.442, and 0.462. Additionally, the flow window method was used to study the Hurst exponent's dynamic behavior. The findings showed that one station's pollution levels had long-term memory, which suggests that the time series is persistent. While anti-persistence was noted in the third and fourth

		sites, data from the second station indicated nearly random behavior. The Hurst exponent values explain the October 2021 spike in pollution levels, which is probably caused by thermal power plants close to the city. The fractal analysis of time series could serve as an indicator of environmental conditions in a given region, with persistent pollution trends potentially aiding in predicting critical pollution events. Anti-persistence or temporary pollution spikes may be influenced by the observation station's proximity to pollution sources. Overall, the findings suggest that fractal time series analysis can act as a valuable tool for monitoring environmental health in urban areas. Keywords: urban air pollution, R/S analysis, time series analysis, Hurst exponent, PM10, PM2.5
14	Toxanov, S. ., Omirbayev, S. ., Abzhanova, D., & Mukhatayev, A. . (2024). EDUCATIONAL PROGRAMMES OF MICROQUALIFICATIONS AS AN EFFECTIVE TOOL FOR IMPLEMENTING THE PRINCIPLE OF CONTINUITY OF EDUCATION IN THE PROFESSIONAL ACTIVITY OF A MODERN UNIVERSITY TEACHER. <i>Scientific Journal of Astana IT University</i>, 19, 179–192. https://doi.org/10.37943/19QLRX8424	The article analyses the introduction of educational programmes of microqualifications as an effective tool for implementing the principle of continuing education in the professional activities of university teachers. Special attention is paid to how microqualifications contribute to the development of competences and adaptation of teachers to the changing requirements of the educational environment. Examples of their use in the practice of higher education institutions are presented, and the impact on improving the quality of teaching and competitiveness of staff is assessed. The relevance of the study is conditioned by rapid changes and new challenges faced by the system of higher education in Kazakhstan. In the conditions of reforming the educational system of the country and the growth of international competition, the integration of microqualification programmes as a strategic approach to the continuous professional development of teachers is of particular importance. The aim of the study is to identify the key challenges and prospects for the development of microqualifications based on the analysis of global and regional educational trends. The paper uses the methods of strategic analysis, as well as comparative-historical approach, which allowed to identify opportunities and threats affecting the development of this system in Kazakhstan. Special attention is paid to the strengths and

	weaknesses of educational programmes, as well as their compliance with modern standards. As a result of the study, recommendations for successful integration of microqualifications into the strategies of HEIs are proposed. Special attention is paid to the creation of strategic partnerships, continuous monitoring of changes in the educational environment and ensuring the high quality of programmes in accordance with international standards. Prospects for the development of microqualifications in Kazakhstan include the development of supra-subject competences and a balance between digital and traditional teaching methods to meet the needs of the target audience and ensure professional development of teachers. Keywords: microqualifications, continuing education, university teacher, professional activity, professional development, educational programmes, quality of training
--	--