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№	Статья и ссылка	Аннотация
1	Kussainov, A., Galymzhankyzy, Z., Akimova, D., Aldasheva, L., & Mukhtarova, Z. (2025). ENHANCED INFORMATION SECURITY FOR VOTING SYSTEM IN EMERGENCIES USING PAILLIER'S CRYPTOSYSTEM. *Scientific Journal of Astana IT University*, *22*, 5–23. https://doi.org/10.37943/22FULA2667	This study explores the application of Paillier's Partial Homomorphic Encryption (PHE) in the context of secure digital voting systems, particularly in emergency situations such as pandemics, natural disasters, or martial law. The proposed system is implemented using Python with the Django framework and the pycryptodome library to ensure a secure and scalable environment. A key feature of Paillier's cryptosystem is its ability to perform computations directly on encrypted data, which preserves voter confidentiality and guarantees data integrity without requiring decryption. A simulated voting scenario involving 10 voters and 3 candidates was conducted to evaluate the system. Encrypted votes were processed using homomorphic operations, allowing for the secure aggregation of votes. The results demonstrated that the system accurately computed vote totals—35 votes for Candidate A, 50 for Candidate B, and 100 for Candidate C—without compromising security. The system proved efficient and reliable for small-scale implementations. However, the study identifies significant challenges when scaling the system to national-level elections. The cryptographic operations required by Paillier's scheme are computationally intensive and could hinder performance when processing millions of encrypted votes in real-time. Therefore, while the system shows high potential for secure e-voting, further research is required to optimize performance. The authors propose future work in two directions: optimizing the underlying cryptographic operations and integrating blockchain technologies to enhance transparency and auditability. Overall, the results suggest that Paillier's PHE provides a robust framework for emergency e-voting systems and offers a substantial improvement over traditional voting methods in terms of both security and privacy. Keywords:

		Paillier's Algorithm, Homomorphic, Python, E-voting, Encryption, Voter Privacy, Data Security
2	Aben, A., Kazbekova, G., Ismagulova, Z., & Ibrayeva, G. (2025). AUDIO-TO-TEXT TRANSLATION FOR THE HARD OF HEARING: A WHISPER MODEL-BASED STUDY. *Scientific Journal of Astana IT University*, *22*, 24–36. https://doi.org/10.37943/22SNOK5872	This study investigates the effectiveness of the Whisper model for audio-to-text transcription, specifically targeting the enhancement of accessibility for individuals with hearing impairments. The research focuses on the processing of audio recordings obtained from WhatsApp messenger, which often contain significant background noise that complicates speech recognition. To address this issue, advanced audio processing techniques were employed, including the use of the Librosa library and the Noisereduce package for noise reduction. The spectral gating methods applied in this study effectively diminished wind noise and other ambient sounds, allowing for clearer recognition of spoken content. To ensure the quality of the processed audio, we assessed its clarity using a SimpleRNN model. The training results demonstrated a progressive reduction in loss values across epochs, confirming the successful enhancement of audio quality. Once the audio files were adequately cleaned, we utilized the Whisper model, a sophisticated machine learning tool for speech recognition developed by OpenAI, to transcribe the audio into text. The transcription process yielded accurate Kazakh language output, despite the initial challenges posed by background noise. These findings underscore the critical role of high-quality audio input in achieving reliable transcription results and highlight the potential of machine learning technologies in improving communication access for hearing-impaired individuals. This study concludes with recommendations for future research, including the exploration of additional noise reduction techniques and the application of the Whisper model across various languages and dialects. Such advancements could significantly contribute to creating more inclusive digital environments and enhancing the overall user experience for individuals with hearing impairments. Keywords: Whisper model, Audio-to-text transcription, Hearing impairments, Machine learning

3	Yershov, E., Nurgaliyev, M., Dosymbetova, G., Zholamanov, B., Orynbassar, S., & Khumarbekkyzy, T. (2025). CLASSIFICATION OF HUMAN EMOTIONS USING THERMOGRAMS AND NEURAL NETWORK . *Scientific Journal of Astana IT University*, *22*, 37–54. https://doi.org/10.37943/22GEBT9085	As information systems and technologies continue to evolve, there remains a noticeable gap in the efficiency and practicality of data processing algorithms, especially in the field of emotion recognition. This study explores several neural network models designed to classify emotions based on thermal images (thermograms). The dataset used for training included 1,642 images, some of which were generated through augmentation, with all images captured while participants viewed emotionally charged videos. The goal was to recognize six basic emotions: joy, sadness, fear, disgust, anger, and surprise. To identify the most effective architecture, the performance of five models were compared: a standard convolutional neural network (CNN), Quadruplet Network, U-Net, Inception, and SqueezeNet. Each model was trained on the same dataset under consistent conditions. Classification accuracy and validation loss were the main evaluation metrics. In addition, data augmentation and early stopping were applied to improve generalization and prevent overfitting. Among the tested architectures, the Inception model achieved the highest test accuracy of 97.5%, while the Quadruplet Network achieved 96.85% accuracy with a lower validation loss of 0.571, indicating stronger generalization. These results suggest that both models are well-suited for real-time emotion recognition using thermal imaging. The findings highlight the potential of combining infrared data with modern neural architectures to advance emotion detection systems beyond traditional RGB-based methods. Keywords: neural network, convolution neural network, thermal imager, emotion recognition, inception, U-net, Quadruplet Network, Squeeze net
4	Omarov, B., Abdrakhmanov, R., & Toktarova, A. (2025). GLOVE-EMBEDDED ATTENTION BILSTM NETWORKS FOR ENHANCED MULTICLASSIFICATION OF TWEETS IN CYBERBULLYING DETECTION ON ONLINE CONTENT. *Scientific Journal of*	This paper offers a neural network method for social media cyberbullying detection and classification. The model uses GloVe-embedded BiLSTM networks with self-attention to recognize language and semantic patterns. The research uses advanced machine learning methods to fight cyberbullying and suggests ways to improve

	Astana IT University, *22*, 55–70. https://doi.org/10.37943/22PSRO3633	cyberbullying detection systems' precision and ethics. The proposed paradigm addresses several cyberbullying levels and forms, enabling targeted interventions and victim support. GloVe implementations do semantic processing, BiLSTM networks sequentially learn, and self-attention mechanisms focus contextual analysis in the model. Word clouds show the abundance and relevance of phrases across several cyberbullying categories, revealing common themes and vocabulary. Tweet lengths, confusion matrix, training and validation loss and accuracy metrics, and ROC curves included in the dataset. The logistic regression model's ROC curve investigation shows substantial classification performance across multiple categories with AUC values between 0.905 and 0.997. The best model for age categorization has an AUC of 0.997, followed by religion (0.996) and ethnicity (0.993). Gender classification has an AUC of 0.979, whereas cyberbullying and non-cyberbullying have 0.921 and 0.905, respectively. The logistic regression model's ROC curve investigation shows substantial classification performance across multiple categories with AUC values between 0.905 and 0.997. The best model for age categorization has an AUC of 0.997, followed by religion (0.996) and ethnicity (0.993). Gender classification has an AUC of 0.979, whereas cyberbullying and non-cyberbullying have 0.921 and 0.905, respectively. The study encourages AI technology for social good and emphasizes the need to improve categorization algorithms to handle cyberbullying language's complex changes. Expanding training datasets, exploring hybrid modeling methodologies, and creating AI application ethics must be future goals. Keywords: cyberbullying detection, deep learning, natural language processing, GloVe embeddings, BiLSTM networks, self-attention mechanisms, social media
5	Zhidebayeva, A., Akhmetova, S. ., Mamikov, S. . ., Kerimbekov, M. ., Aldeshov, S., & Shaimerdenova, G. (2025). DETECTION OF HATE SPEECH ON SOCIAL MEDIA	This article investigates the identification of hate speech on social media using machine learning and deep learning techniques. The research uses metrics such as F-measure, AUC-ROC, precision, accuracy, and recall

	UTILIZING MACHINE LEARNING. *Scientific Journal of Astana IT University*, *22*, 71–87. https://doi.org/10.37943/22SKSG8575	assessing the effectiveness of various tactics. The findings indicate that deep learning models, particularly the bidirectional long short-term memory (BiLSTM) architecture, consistently outperform other methods in categorization tasks. The research emphasizes the importance of sophisticated neural network designs in identifying the intricacies of hostile and offensive content online. The study offers insights for promoting early identification and prevention of cyberbullying, improving secure and inclusive online environments. Future research may explore real-time detection systems, hybrid approaches, or the integration of complementary components to enhance and improve innovative technology in tackling this significant social issue. A sample tweet was annotated by specialists who categorize tweets as hate speech, offensive language, or neutral. The researchers applied shallow learning methodologies and integrated word embeddings like Word2Vec and GloVe to enhance the efficacy of deep learning models. The results indicate that BiLSTM surpasses shallow learning methods in detecting hate speech on Twitter, highlighting the efficacy of deep learning approaches in recognizing and tracking hate speech on social media platforms. When comparing different deep learning and machine learning models on different datasets, the results reveal that deep learning techniques are usually more effective. A reasonably high level of accuracy is achieved by KNN and SVM among classical algorithms, whereas Naïve Bayes performs the poorest. While deep learning approaches provide better results, tree-based models such as Random Forest and Decision Trees offer more consistent accuracy. Models based on neural networks, such as LSTM, CNN, and BI-LSTM, perform well, with LSTM-based methods excelling in particular. The most successful strategy for classification problems is the model presented, which obtains the greatest accuracy, precision, recall, F1-score of 95%. The research aids in the development of advanced tools and methodologies to mitigate hate speech on social media and

		foster positive online interactions. Future research may investigate alternative deep learning architectures, such as transformers, to enhance hate speech detection efficacy. The advancement of interpretable AI methodologies for identifying hate speech and delivering transparent forecasts might enhance user confidence and facilitate better content moderation decisions. Keywords: hate speech, machine learning, natural language processing, detection, social media
6	Nazyrova, D., Aitkozha, Z., Kerimkhulle, S., & Omarova, G. (2025). COMBINED APPROACH BASED ON HARALICK AND GABOR FEATURES TO CLASSIFY BUILDINGS PARTIALLY HIDDEN BY VEGETATION. *Scientific Journal of Astana IT University*, *22*, 88–104. https://doi.org/10.37943/22YNTU3695	Classification of urban area is important for urban planning, infrastructure management and detection of illegal constructions. However, automatic object recognition in urban environments is difficult due to textural similarity of materials, varying lighting conditions and partial overlap of buildings with vegetation. The identification of buildings partially hidden by green spaces is particularly challenging because their boundaries merge with the surrounding environment, which reduces the accuracy of traditional classification methods. In this study, a stepwise approach to object classification in aerial images is proposed to improve the recognition of buildings partially hidden by vegetation. The analysis was performed in two stages using three-channel high-resolution aerial images acquired from an unmanned aerial vehicle. In the first stage, classification was performed based on Haralick features computed from a co-occurrence matrix of gradations, which allowed the extraction of statistical texture features. However, this was insufficient for accuracy, so in the second stage, a Gabor filter was additionally applied to provide analysis of local texture features, taking into account the frequency and orientation of image elements. The final classification was performed using Random Forest algorithm, which allowed to divide objects into three categories: "buildings", "vegetation" and "buildings partially hidden by vegetation". The classes "buildings" and "vegetation" were considered as auxiliary, providing quality control of the classification and allowing us to focus on improving the recognition of objects partially occluded by vegetation. Experimental results confirmed

		that the proposed method is effective for recognizing buildings partially hidden by vegetation. The inclusion of the Gabor filter improved the classification accuracy of this class from 0.84 to 0.90, the completeness from 0.74 to 0.86, and the F1-estimation from 0.79 to 0.88. The 11% improvement in completeness is particularly important because it indicates a reduction in the number of missed buildings. In comparison, the classification accuracy of fully visible buildings increased from 0.84 to 0.91 and that of vegetation from 0.88 to 0.95. Thus, the proposed method, which combines global and local texture features, demonstrated high performance to improve the identification accuracy of complex objects whose boundaries merge with the surrounding vegetation. Keywords: texture analysis, Haralick features, Gabor filter, image classification, Random Forest
7	Mimenbayeva, A., Turebayeva, R., & Konurkhanova, A. (2025). DEVELOPMENT OF IMAGE CAPTION GENERATION HYBRID MODEL. *Scientific Journal of Astana IT University*, *22*, 105–121. https://doi.org/10.37943/22UGEU1808	This study presents a hybrid model for image captioning using a VGG16 convolutional neural network (CNN) for feature extraction and a long short-term memory (LSTM) network for sequential text generation. The proposed architecture addresses the challenges of producing semantically rich and syntactically accurate signatures, especially in languages with limited training data. The model effectively bridges the semantic gap between visual and textual modalities by utilizing pre-trained weights and a robust encoding-decoding system. Experimental results on a dataset of road signs in Kazakhstan show a significant improvement in inscription quality as measured by BLEU and METEOR metrics. The model achieved a maximum METEOR score of 0.9985, indicating high semantic accuracy, and BLEU-1 and BLEU-2 scores of 0.67 and 0.64, respectively, highlighting the model's ability to generate relevant and coherent captions. These findings underscore the model's potential applications in multimodal systems and assistive technologies. Using a pre-trained CNN model (VGG16), we can efficiently encode visual information by extracting high-level features from images. This approach is particularly useful for tasks that require

		consideration of the semantics of images, such as road sign recognition. The second LSTM model, as a sequence-oriented architecture, is well-suited for text generation, as it effectively considers the context and previous words in a sequence. These models can be integrated into systems requiring the analysis and description of visual information, such as autonomous vehicles or driver assistance systems. In conclusion, the proposed model demonstrates high potential for image caption generation tasks, especially in resource-constrained environments and for specialized datasets. Keywords: image captioning, deep learning, CNN-LSTM, VGG16, multimodal learning, BLEU metrics, METEOR metrics, natural language processing, neural networks, assistive technologies
8	Sadvakassova, A., & Yessenov, A. (2025). METHODS OF INFORMATION SECURITY IN THE INTERNET OF THINGS (IOT) NETWORKS USING QUANTUM MACHINE LEARNING. *Scientific Journal of Astana IT University*, *22*, 122–133. https://doi.org/10.37943/22JIEN1491	The development of the Internet of Things (IoT) poses serious security challenges due to the vulnerability of devices and network connections. IoT devices often have limited computing resources, which makes it difficult to implement traditional security methods such as encryption and intrusion detection systems. In addition, the dynamic nature and high complexity of IoT networks create additional security challenges, requiring the development of new, more effective security methods. Traditional machine learning algorithms used to protect IoT networks have their limitations in terms of scalability and ability to effectively cope with large volumes of data, as well as new types of threats. These algorithms are often unable to quickly respond to anomalies, which significantly increases the risk of cyberattacks. In this regard, there is a need to find new solutions to improve the security of IoT networks. This paper proposes a new approach to IoT security using quantum machine learning (QML), which combines the capabilities of quantum computing with machine learning algorithms to create more powerful models for detecting threats and anomalies in IoT networks. We analyze various QML algorithms, such as quantum support vector machines (QSVMs), quantum neural

		networks (QNNs), and quantum reinforcement learning (QRL), applied to solve security problems. Experiments conducted using the dataset confirm the effectiveness of quantum algorithms compared to traditional machine learning methods. The results show that QML models provide higher accuracy in detecting threats and anomalies, and significantly reduce the time spent on processing and training compared to classical methods. In conclusion, we argue that using QML to protect IoT networks can significantly improve their security and efficiency, opening up new prospects for further research in this area. Keywords: Internet of Things, information security, quantum machine learning, machine learning algorithms, IoT network security, quantum support vector machines , quantum neural networks , quantum reinforcement learning , data security
9	Baigabyl, R., Nugumanova, A., & Sodnomova, M. (2025). USING GRAPH CENTRALITY METRICS FOR DETECTION OF SUSPICIOUS TRANSACTIONS. *Scientific Journal of Astana IT University*, *22*, 134–152. https://doi.org/10.37943/22ZSKI6025	This study addresses the critical challenge of detecting suspicious transactions in modern financial networks, focusing on the persistent threat of money laundering and related fraudulent activities. We propose a graph-based approach where each financial participant—whether an individual or an institution—is modeled as a node, and directed edges represent the flow of transactions. Using a dataset of anonymized banking records, we construct a directed graph and then calculate centrality measures, including degree centrality, betweenness centrality, closeness centrality, and eigenvector centrality. These metrics quantify how actively each node participates in or controls the circulation of funds across the network. Nodes characterized by particularly high values for betweenness or degree centrality emerge as potential "bridge" entities, acting as conduits for the majority of transaction paths. Our results indicate that these high-centrality participants may be key to understanding illicit financial flows, because they facilitate significant volumes of transactions or exert disproportionate influence by connecting otherwise separate sub-networks. Furthermore, a visualization of subgraphs

		around these nodes reveals tightly knit structures, suggesting the presence of possible hidden clusters that could be orchestrating complex money-laundering schemes. Overall, the proposed network-driven approach provides an efficient lens for early detection of suspicious accounts and transaction routes, especially when integrated with contemporary machine learning technologies for real-time analytics. The study concludes that centrality-based screening can enhance both the speed and accuracy of anti-fraud interventions, thereby strengthening the resilience of financial institutions in an increasingly data-rich and interconnected global economy. Keywords: social network analysis, centrality measures, financial fraud detection, betweenness centrality, anti-money laundering, transaction networks, graph-based anomaly detection, explainable AI
10	Kairatuly, B., & Shomanov, A. (2025). BALANCING SPEED AND PERFORMANCE WITH LAYER FREEZING STRATEGIES FOR TRANSFORMER MODELS. *Scientific Journal of Astana IT University*, *22*, 153–162. https://doi.org/10.37943/22OXKY5402	In this paper, we evaluated different approaches to freezing BERT-base layers and analyzed their impact on the quality and speed of training in the task of named entity recognition in two languages. Layer freezing is an optimization technique in deep neural network training in which specific layers of a model remain fixed. This means their weights do not change during the backpropagation process. By not updating these layers, the overall number of parameters requiring adjustment is reduced, which results in lower computational demands and faster training times. Partial freezing of layers proved to be an effective way to preserve key representations of the model and ensure its adaptation to new tasks. Experimental results showed that freezing from three to six layers allows to achieve stable model performance regardless of the training language. Unlike standard approaches, our method highlights cross-linguistic applicability and promotes energy-efficient training. We personally designed the experimental setup, implemented the freezing scenarios, and carried out all performance evaluations. This study aims to evaluate the effectiveness of layer freezing in a pre-trained BERT model when performing the named entity recognition task. Two

		variants of the freezing strategy are considered: in the first one the upper layers of the model are fixed, in the second one the lower layers remain unchanged. The analysis is based on two corpora, the English language CoNLL 2003 and the Kazakh language KazNERD. Our experiments showed that freezing three to six layers provides the best balance between training speed and model quality. On the CoNLL-2003 dataset, the training time decreased from 266 to 167 seconds and the Macro F1 score remained at 87%. On KazNERD, learning accelerated from 1609 to 958 seconds with an accuracy of 94-95 % and Macro F1 in the range of 71-72 %. Full freezing of all 12 layers caused a dramatic drop in quality, with Macro F1 dropping to 50 % on CoNLL and to 7 % on KazNERD. This emphasises the importance of limited freezing and fine-tuning of the model architecture. The study further examines how the choice of layers to freeze influences the model's ability to adapt to new linguistic patterns and domain-specific terminology. These findings offer useful insights for researchers and practitioners aiming to enhance the efficiency of fine-tuning large language models while ensuring robust performance across different languages and datasets. The results also highlight the potential for optimizing resource usage in various NER applications without compromising critical language understanding. Keywords: layer freezing, BERT, NER, English, Kazakh
11	Zhukabayeva, T., Adamova, A., Abdildayeva, A., & Karabayev, N. (2025). EVALUATING AN ANALYTICAL MODEL OF CYBERATTACK EFFECTS ON AN IIoT SYSTEM WITH EDGE COMPUTING CAPABILITIES. *Scientific Journal of Astana IT University*, *22*, 163–173. https://doi.org/10.37943/22DOKU3034	The Industrial Internet of Things (IIoT) is an important component of future industrial systems. Implementing edge computing in the IIoT can significantly reduce decision latency, save bandwidth resources, and protect privacy to some extent. But it is important to realize that edge computing is often resource-constrained, and devices are often spread across vast geographic areas, including intermittent network connectivity. Such conditions increase security vulnerabilities due to increased attack surfaces and physical availability. This paper addresses the problem of securing IIoT systems utilizing the concept of edge

		computing. An analytical model of attack influences is proposed, including typical scenarios and individual steps of attacks, both physical and software-informational in nature. The presented analytical model is designed to assess and analyze attack impacts on IIoT, implements the concept of boundary calculations, allows to analyze vulnerabilities of IIoT systems more effectively and develop measures to protect them. The model is designed to provide a comprehensive tool for securing critical infrastructures. The model includes typical attack scenarios, detailed attack steps, and impact classification. The developed model can be used for risk analysis, development of protection strategies, and security testing of IIoT systems. The conducted experimental study confirmed the relevance and practical significance of the developed model. The results of the study showed that IIoT-systems using edge computing are subject to a wide range of threats. The most critical are DoS attacks and Data Integrity Attacks. The obtained results emphasize the need to apply comprehensive security measures for IIoT systems with edge computing and confirm the effectiveness of the proposed analytical model. Keywords: Industrial Internet of Things, edge computing, cybersecurity, threat model, attacks, physical attacks, software and information attacks, analytical model
12	Aubakirova, A., Biloshchytskyi , A. ., Orazbay , M. ., Kazambayev , I. ., & Neftissov , A. . (2025). DEVELOPMENT OF THE INTEGRATED WATER RESOURCES MONITORING AND FORECASTING MODULE FOR DECISION SUPPORT SYSTEMS AT HYDROTECHNICAL STRUCTURES. *Scientific Journal of Astana IT University*, *22*, 174–188. https://doi.org/10.37943/22NEJN3212	Nowadays, it is necessary to use monitoring and forecasting technologies for effective water resources management at water management facilities. The objective of this study is to develop and verify an integrated approach to water resources forecasting with the task of identifying features for forecasting, designing a data preprocessing submodule and a forecasting module. The workflow diagram of the water forecasting system includes sequential stages of data collection, preprocessing, filtering, feature extraction, and training. Sentinel-2 and MODIS satellite sources were used for data preprocessing. Predictors for the formation of time series by normalized difference water index (NDWI) and water surface temperature (LST) were selected in the

		feature engineering stage. The XGBoost Regressor algorithm was chosen due to its ability to model nonlinear relationships and feature interactions. Excluding winter months improved the model performance for all metrics, which demonstrates the importance of seasonal filtering when working with optical satellite data. The machine learning algorithm takes into account the analysis of satellite data (NDWI and LST indices) through the Google Earth Engine (GEE) platform. Both seasonal and long-term dynamics of water volumes in the Tasotkel reservoir are monitored for the period from 2020 to 2024. In practice, image initial filtering submodules were developed using linear regression and the XGBoost model. Model trained without winter data shows high performance using Metrics Mean Absolute Error (MAE) of 52.793, Root Mean Squared Error (RMSE) of 60.276, coefficient of determination (R^2) of 0.673 and Mean Squared Error (MSE) of 3633.252 metrics. However, a decrease in clarity was observed due to snow and ice on reflective properties in winter. For the purpose of rational water resources management, the combination of satellite images and machine learning algorithms in this study shows the prospects for development. Keywords: machine learning, remote sensing, water resources monitoring, predictive mod-eling, reservoir
13	Kuatbayeva, A. ., Sergaziyev , M. ., Yedilkhan , D. ., Issenov , D., & Gizatov , A. . (2025). MULTI-OUTPUT BUS TRAVEL TIME PREDICTION USING CONVOLUTIONAL LSTM NEURAL NETWORKS. *Scientific Journal of Astana IT University*, *22*, 189–205. https://doi.org/10.37943/22JALW4601	Ensuring accurate and dependable predictions of bus arrival times is essential to improving public transportation services and maintaining their appeal in urban settings. Such predictions, whether displayed on electronic boards or integrated into mobile applications, enable passengers to make better travel decisions, such as choosing alternate routes, anticipating delays, or avoiding missed connections. Furthermore, advanced Intelligent Transport Systems (ITS) utilize this information to facilitate smoother passenger transfers by holding delayed services within predefined limits. However, as urban congestion and travel time unpredictability grow, traditional methods face significant challenges in providing reliable predictions, making the problem increasingly complex. This research

		focuses on developing a robust system for forecasting bus arrival times in Astana city, utilizing extensive spatio-temporal data from two datasets. Multiple machine learning and deep learning models are implemented and compared to achieve this goal. These include K-means clustering to classify bus routes, K-Nearest Neighbors (KNN) for predictions based on proximity, and a Conv-LSTM model, which integrates convolutional and long short-term memory layers to address intricate temporal and spatial correlations. Support Vector Machines (SVM) and regression models are also incorporated to establish benchmarks and comparative insights. Through empirical evaluation, the proposed models demonstrate varying strengths, with the Conv-LSTM model showing exceptional performance in adapting to dynamic urban conditions and detecting subtle fluctuations in bus travel times. The findings highlight the transformative potential of sophisticated predictive modeling techniques to enhance urban transit systems, ensuring passengers receive timely and accurate information while improving overall operational efficiency. Keywords: Bus arrival prediction, public transportation, Conv-LSTM, K-means clustering, spatio-temporal data, urban transit systems, machine learning, deep learning, Intelligent Transport Systems (ITS)
14	Chigambayeva, D., Goryakin, M., & Batova, P. (2025). EDUCATIONAL FLOWS DISTRIBUTION SYSTEM OF UNIVERSITY ACADEMIC GROUPS. *Scientific Journal of Astana IT University*, *22*, 206–219. https://doi.org/10.37943/22VHYR8574	Planning of educational flows and academic groups by the Academic department is one of the responsible, complex and labor-intensive tasks solved at the stage of the educational process preparation in the university. When planning the work, the Academic department strives to improve the quality of work in order to achieve the best indicators for the types of educational work. One of the main tasks of the IT educational programs is the data analysis and construction of an automated system. Wide opportunities for the implementation of this goal are provided by the topic of scientific research, which is relevant both for the Academic department, which makes up the teaching load of the university, in which educational flows are involved, and for the university as a whole,

		for the teaching staff of all educational departments. The problem under consideration is really relevant in each higher educational institution and is of scientific interest due to the fact that insufficient attention is paid to mathematical modeling in software development. The aim of the paper is the development and software implementation of the automated system in Python to optimize the business process of distributing educational flows. For the efficiency of writing business processes for optimizing the formation of educational flows and academic groups, the architecture, algorithms and functional model of the software product are described. The functional model of the business process of forming educational flows and academic groups participating in the teaching load calculation at the stage of the educational process preparation at the university is considered. Moreover, the innovative product prototype has been created, which allows us to distribute educational flows evenly and quickly to a large extent, while fulfilling the accepted criteria and limitations of the model. The paper describes the architecture, algorithms and functional model of the software product, which corresponds to the IT field. The development of this innovative program will be useful both for beginners in Python programming and for developers creating their startups. Keywords: educational flows, educational process, educational work, types of educational work, teaching load, functional model, automated system, Educational Program Design