

Brief information about the project

Name of the project	AP26195405 Development of combined models of deep neural networks for the interpreted analysis of medical images
Relevance	The relevance of this project is driven by the high prevalence of acute stroke and the need for rapid and accurate diagnosis based on MRI and CT brain images. Although deep learning methods in medical computer vision are rapidly advancing, most existing neural network models lack interpretability, which limits their adoption in clinical practice. Therefore, the development of interpretable neural network models capable of not only detecting pathological changes but also explaining their decisions in a way understandable to clinicians is an important scientific and practical task aimed at improving diagnostic quality and healthcare outcomes.
Purpose	The main goal of the project is to research and develop interpretable models of neural networks used in medical computer vision to solve practical problems of automated diagnostics. These models are used to create a diagnostic system for acute stroke, which is then planned to be implemented in clinical practice.
Objectives	1. Architecture design and software implementation of a deep neural network combining a convolutional neural network, a decision tree method based on the similarity of objects and a trainable "bag" of visual words. Substantiation of the requirements for displaying neural network results that contribute to achieving an optimal understanding of solutions based on the created architecture. 2. Development of a repository of annotated MRI brain scans that are used for neural network training, and development of a patient database. Analysis and selection of confirmed cases of acute stroke, as well as patients without diseases, in order to create training and test datasets for clinical research. The annotation of pathological changes in the training sample is carried out by medical experts. 3. Development of user-friendly neural network deep learning models that are able to identify significant data features and explain their decisions using logically probabilistic statements that are understandable to the end user. 4. Development of neural networks using weak control and self-learning approaches designed to work effectively with data with incomplete and/or erroneous annotations. 5. Creating an interface for entering training set data into the platform, as well as for visualizing the results of image processing using professional medical terminology. 6. Introducing into clinical practice, it verifies the developed models of neural networks for medical use as a prototype of an intelligent system designed to detect acute

	stroke through the analysis of MRI and CT images of the brain. 7. Perform a comparative analysis, focusing on a retrospective study of the specificity, sensitivity, and positive and negative prognostic significance of the improved neural network model in comparison with experts in the field of computed tomography.
Expected and achieved results	1. As a result, a software architecture will be developed and algorithms will be proposed for interpreting the results of image processing — the key goal of the study. A method will be created that allows you to recognize images and present interpretations in an understandable form. The parameters of the neural network representation in the form of a decision tree will also be determined: the depth of the tree, the metrics of similarity of objects in nodes and the criteria for completing branches. 2. To create a database of annotated images, retrospective MRI data on acute stroke cases will be used. Experts will analyze and select confirmed cases with acute stroke and without pathologies, forming training and test samples. Pathology zones will be marked in the training set, which will allow the neural network to perform probabilistic and logical analysis of pixels. 3. Interpretable models of deep learning neural networks will be developed, capable of highlighting key data characteristics and explaining their conclusions through logically consistent and understandable to users. 4. A prototype neural network will be created that uses weak control and self-learning methods to isolate significant features from data based on a model of visual words. Digital images, including three-dimensional MRI and CT scans of the brain of stroke patients, will be used as initial data. 5. An interface will be created that allows you to enter the data of the training set into the platform and provides tools for visualizing the results of image processing using professional medical terminology. 6. The development of a neural network model designed for the diagnosis of acute stroke will be completed. This process will include testing the model and comparing it with existing analogues based on real medical images, as well as introducing the model into clinical practice. The developed neural networks are being tested for medical use as a prototype of an intelligent system that is designed to detect acute stroke. 7. Analysis of neural network quality indicators (such as specificity, accuracy, sensitivity, and others) in comparison with the qualifications of medical diagnosticians. Integration of this system into clinical practice as an intelligent assistant for doctors.
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Usage	Integration of this system into clinical practice as an intelligent assistant for doctors.
Priority compared to real-world alternatives	Unlike most existing similar systems, the system we have developed has a key advantage: it can not only establish a final diagnosis, but also provide explanations in the form of a tree of intermediate solutions.
List of publications with links to them	Cherikbayeva, L., Berikov, V., Melis, Z., Yeleussinov, A., Baigozhanova, D., Tasbolatuly, N., Temirbekova, Z., & Mikhailapov, D. (2025). Ensembling Transformer-Based Models for 3D Ischemic Stroke Segmentation in Non-Contrast CT. <i>Applied Sciences</i>, 15(17), 9725. https://doi.org/10.3390/app15179725 Q1
Patents	-