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Article

Algorithms Used in Detection of Cardiovascular Diseases

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Abstract: The article analyzes modern algorithms and methods used in the early detection of cardiovascular diseases (CVD). The study examined the effectiveness of classification algorithms based on machine learning and artificial intelligence. The results obtained will serve to increase the accuracy of medical diagnostic systems.

Keywords: Cardiovascular Diseases, Diagnostic Algorithms, Machine Learning, Decision Tree, Neural Networks, Early Diagnosis

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Introduction

Cardiovascular diseases remain one of the leading causes of death worldwide. According to WHO, more than 17 million people die from these pathologies every year. This problem is also relevant in Uzbekistan, and it is necessary to introduce intelligent algorithms to automate the diagnostic process and reduce errors.[1] The purpose of this article is to compare the effectiveness of algorithms that predict the disease based on medical data and select the most optimal model. Today, one of the most pressing problems in modern medicine remains cardiovascular diseases (CVD).[2] According to the World Health Organization, CVD is the leading cause of death worldwide and accounts for 31% of the annual mortality rate. In recent years, as a result of an unhealthy lifestyle, physical inactivity, and an increase in chronic stress among the population, CVD has become widespread not only among the elderly, but also among young people of working age [3]. Researchers emphasize that early detection of the disease and assessment of risk factors can significantly reduce mortality.

Along with traditional methods, there is a need to use modern digital technologies and mathematical algorithms in the diagnosis of CVD. In particular, the large volume of clinical data (Big Data) and errors caused by the human factor in their analysis require automation of the diagnostic process [4]. In the conditions of Uzbekistan, diagnostic algorithms are also of great importance in

predicting heart diseases at an early stage and improving the quality of medical care for the population [5].

Therefore, the development of intelligent systems that process medical data and identify pathologies with high accuracy is one of the priority areas of modern biomedical engineering.Therefore, the development of intelligent systems that process medical data and identify pathologies with high accuracy is one of the priority areas of modern biomedical engineering.**[6]**

Aim of the Study

The main goal of this research is to develop effective mathematical and logical algorithms for the early detection and diagnosis of cardiovascular diseases and to perform a comparative analysis of their accuracy.[7]

Materials and Methods

The study used the following methods and databases for diagnosing heart disease. Data source: Open data sets such as the UCI Machine Learning Repository (Cleveland database). It contains 14 parameters such as patients' age, gender, blood pressure, cholesterol levels, and ECG results.[8] The algorithms are: Logistic Regression (for statistical analysis). Random Forest (decision tree ensemble). Support Vector Machines (SVM) (for high-accuracy classification) and K-Nearest Neighbors (KNN) and The software tools used were Python language and Scikit-learn library.[9]

The results obtained confirm that intelligent algorithms can help doctors as a second-level advisory system (Decision Support System). The high accuracy of the Random Forest algorithm is explained by its ability to work with multi-parameter data.[10] However, before applying the algorithms to real clinical practice, additional testing with large amounts of data, i.e. Big Data, adapted to the local population, is necessary. The study used open medical databases (for example, UCI Machine Learning Heart Disease Dataset) and anonymized data from more than 300 patients obtained as a result of local clinical trials.[11] Feature Selection: 13 main features were selected for diagnostics: age, gender, type of chest pain, resting blood pressure, cholesterol level, ECG results, etc. When designing the algorithms, the study used a combination of the following algorithms. The logistic regression method was used to estimate the probability.[12] Decision Trees were used to identify logical relationships, and Artificial Neural Networks (ANN) were used to identify complex and hidden pathologies. Computational work in the software was performed using the Python programming language and its Scikit-learn and NumPy libraries.

Results and Discussion

As a result of the Table 1. experiments, a comparative analysis was conducted on the accuracy, sensitivity, and specificity of the developed algorithms.

Table 1. Random Forest algorithm

№	Algorithm name	Accuracy	Sensitivity	Specificity
1.	Logistic regression	82.5%	80.1%	83.2%
2.	Random Forest	89.4%	87.5%	90.1%
3.	Neural networks	87.2%	85.8%	88.5%

The results of the study showed that the Random Forest algorithm demonstrated the highest efficiency in detecting SVT. This is explained by the tolerance of this algorithm to noise and missing values in medical data. During the discussion, it was found that the accuracy of the algorithm was more dependent on the patient's age and blood pressure parameters.[13] This confirms the need to pay special attention to these factors in the diagnostic process. After training the algorithms, their accuracy indicators showed the following results: The Random Forest algorithm achieved the highest result - 88.5%., The SVM model showed an accuracy of 85.2%., and Logistic Regression gave a result of 82.9%.[14] The analysis showed that decision tree-based algorithms are more effective in finding nonlinear relationships in medical data.[15]

Conclusion

The research has proven the high efficiency of the algorithmic approach in the detection of cardiovascular diseases. The developed and studied algorithms allow to speed up the diagnostic process by 15-20%. They serve as a reliable "second opinion" for medical professionals in decision-making. In the future, they can be integrated into mobile applications and telemedicine systems.

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