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OVERVIEW OF EARLY DIAGNOSIS OF «DIABETES» BASED ON ARTIFICIAL INTELLIGENCE

Abstract: *The review presents the possibilities of using artificial intelligence to study the mechanisms of development of diabetes mellitus (DM) and create new technologies for its prevention, monitoring and treatment. In recent years, a huge array of molecular data has been accumulated that reveal the pathogenetic mechanisms of the development of diabetes mellitus and its complications. Intellectual analysis of data and texts of scientific publications (data mining and text mining) opens up new possibilities for processing this information. Analysis of molecular genetic networks makes it possible to identify molecular interactions that are important for the development of diabetes mellitus and its complications, as well as to identify new targeted molecules. Based on the analysis of big data and machine learning, new platforms have been created for the prognosis and screening of diabetes mellitus, diabetic retinopathy, chronic kidney disease, and cardiovascular complications. Machine learning algorithms are used for personalized glucose prediction, closed-loop insulin delivery systems, and decision support systems for lifestyle modification and diabetes treatment.*

Key words: *diabetes mellitus, artificial intelligence, machine learning, data mining, text mining, gene networks, decision support systems.*

Language: *English*

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Introduction

Artificial intelligence (AI) is the science and technology of creating intelligent systems, i.e. systems capable of performing functions previously peculiar only to humans: including the ability to correctly interpret external data, learn from such data and use the knowledge gained to achieve specific goals and objectives through flexible adaptation. AI and the systems based on it are one of the most important scientific achievements of the modern era. Even in everyday life, a person is faced with many things related to AI in one way or another: a voice assistant in a mobile device, "smart" watches, computer chess, etc. In recent years, AI has penetrated all spheres of human life, including medicine. Analysis of the Web of Science database showed an increase in the number of publications devoted to the use of AI in biomedical research: since 1995, the

annual growth has averaged 17%, in the period from 2014 to 2019. - about 45%. AI is most often used in the study of cancer, depression, Alzheimer's disease, heart failure, and diabetes mellitus (DM) [1].

The purpose of this review was to analyze the possibilities and main achievements in studying the pathogenesis of diabetes, improving methods of its prevention, screening and treatment using AI. Sources were searched for the keywords "artificial intelligence" and "diabetes" in the Pubmed / Medline database. Considering the large amount of work on the problem, we mainly present the results of the studies of the last 5 years.

Artificial intelligence: directions and approaches

The emergence of AI is associated with the creation of electronic-mechanical devices, the behavior of which can be programmed using a set of certain rules applied in accordance with the input data and the internal logic of actions. The need for AI systems was due to the appearance in the 40s and 50s. XX century tasks that were difficult or impossible for a person to solve, but which were quite within the power of electronic devices of that time: decoding secret enemy messages, planning military operations, etc. Further development of AI received a theoretical basis in the form of fundamental works by A. Turing, C. Shannon, J. McCarthy, F. Rosenblatt and other researchers, in which the main provisions of the theory of algorithms, machine learning (ML), information theory, artificial neural networks were formulated , programming languages. The elemental base of AI systems was constantly being improved (from vacuum tubes to transistors, then to integrated circuits), making it possible to solve more and more complex problems.

In the course of the development of AI, various directions have been formed, among which several main ones can be noted [2]. Historically, one of the first to emerge was symbolic and logical approaches, in which it is assumed that objects of the real world, data, knowledge can be formalized by some symbols and operations with them, expressed in the language of mathematical logic. Logic programming languages have been developed for specific applications of the logical approach. The agent-oriented approach is based on the concept of an agent as a self-learning system that can perceive environmental signals and influence this environment in order to optimize certain quality indicators. Example-based statistical learning assumes that existing data contains hidden patterns that can be detected and analyzed to make predictions and decisions. In this approach, known as ML or data mining (IAD), the apparatus of the theory of probability and mathematical statistics, optimization methods are widely used.

Depending on the method of setting the target attribute, the following types of ML problems are considered.

1. Supervised learning. It is used when it is required to build a decision rule (predictive model) based on the initial sample, as well as based on the values of the target attribute specified for all of its elements. Depending on the type of the target feature, there are problems of regression analysis, where the predicted feature can take real values, and classification (pattern recognition), where the target feature is some class label belonging to a set of non-numeric nature. In tasks that take into account the time factor, it is necessary to predict the value of the target feature in future moments.

2. Unsupervised learning. In this case, the target attribute is not specified; This group of problems includes cluster analysis, where it is required to split a set of observations into homogeneous groups, and dimensionality reduction problems, in which it is necessary to form a system of features of a lower dimension without losing essential information.

3. Semi-supervised learning. This method is used when training information in the form of a set of values of the target feature is available only for a part of the sample, as a rule, of a relatively small size.

There are several basic approaches to solving problems. The probabilistic approach is based on the idea that the data is obtained in accordance with some probabilistic distribution. The distribution model can be estimated from observations and used to obtain optimal solutions (for example, giving a minimum estimate of the probability of a pattern recognition error). In this approach, Bayesian inference is widely used, based on the calculation of the posterior probabilities of classes using the Bayes formula using known a priori probabilities and a distribution model. In the "naive" Bayesian classifier (Naive Bayes; NB), statistical independence of features is assumed. When studying processes that change in time, the concept of Markov chains is used, in which random transitions of a certain system on a set of discrete states are modeled.

The metric approach is applicable to numerical features and uses an analogy with geometric points representing the original sample in a multidimensional Euclidean space. The predictive decision is made by analyzing the metric properties of the sample, for example, by searching for the closest points in the k-Nearest Neighbors (k-NN) method. The same approach includes linear classifiers based on the search for the optimal dividing hyperplane (Fisher's linear discriminant); Support Vector Machine (SVM), which searches for a maximum width band separating points of different classes, as well as generalizations of this method to the case of a regression analysis problem (Support Vector Regression; SVR) and linearly inseparable classes (SVM using the kernel) ; linear regression analysis and its generalizations;

model of logistic regression (Logistic Regression; LR).

The next approach is based on finding logical patterns in the data and using patterns when making decisions. A convenient form of representing patterns is a Decision Tree (DT), which is a visual hierarchical model of the studied dependence. When forming DT, a step-by-step selection of the most important predictors and automatic screening of noise, uninformative features are carried out. The advantage of this approach is that it allows analysis of both numeric and non-numeric attributes.

One of the main learning technologies is Artificial Neural Networks (ANN), in particular, the Multilayer Perceptron, which simulate the functioning of biological neurons when processing signals arriving at them. Recently, deep neural networks have been actively developing, demonstrating significant progress in visual recognition and natural speech processing (Natural Language Processing; NLP) [3]. Various deep ANN architectures are used, such as Deep Convolutional Networks based on linear transformation; deep recurrent networks (Recurrent Neural Networks), used to simulate various sequences, etc.

The collective (ensemble) approach in ML makes it possible to use the advantages of various algorithms included in the ensemble to increase the predictive power of solutions. There are adaptive ensemble building methods (called boosting) and methods in which base decisions are randomly generated independently of each other (bagging). The methods of boosting decision trees and the random forest (RF) method have proven themselves well, using DTs generated from random subsamples as basic elements.

To find optimal solutions in ML, modern optimization methods are used, such as the Stochastic Gradient Descent method for training neural networks, genetic and evolutionary programming, which allow to effectively solve complex optimization problems when analyzing large data arrays.

Conclusion

The introduction of systems based on artificial intelligence is in line with global trends in modern medicine, including the transition to digital and remote technologies, personalization of treatment, high-precision forecasting and a patient-centered approach. There is an obvious need for further research in this direction, with an assessment of the clinical effectiveness of new technologies and their economic justification.

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