ISSN: 0976-3104
SPECIAL ISSUE: COMPUTER SCIENCE

ARTICLE

THE PROBLEMS OF CREATING EXPERT SYSTEMS USING ARTIFICIAL NEURAL NETWORKS AND THEIR USE IN MEDICINE

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ABSTRACT

The task of our project is the development of an expert system, including the development of an artificial neural network that will help doctors in the analysis of collected data about the patient and the diagnosis. It is planned to develop a system using modern information technologies, such as image recognition methods, as well as the principles of neural network interaction intended for informational support of medical solutions in the field of endocrinology. It is planned to use the general method of decision-making using the principles of automated theorem proving and introspection. The main problems in the field of creation of medical expert systems will be analyzed, and with their help the software part of the system will be developed: disease detection, exemplified by diabetes detection, on the basis of a set of analyzes and symptoms of the patient. The future system will be designed to classify, diagnose, assess the patient's condition, and to make and correct treatment orders.

KEY WORDS
artificial intelligence, artificial neural networks, database, expert systems, diabetes.

INTRODUCTION

Nowadays, expert systems have insufficiently high competence in the field of making medical decisions and therefore have no use in practice. Medical expert systems are used in various fields of clinical medicine. For example, the software product "Aibolit", which is designed to diagnose, classify and correct treatment of acute circulatory disorders in children, as well as the expert system "Doctor's Companion".

One of the main problems in medicine is detecting diabetes [1]. A lot of people around the world have it, but not everyone knows about it. Today exists a lot of methods for detecting various diseases.

METHODS

The goal is to create an expert system in medicine with the use of artificial neural networks, which will help doctors in analyzing the collected data about the patient and the diagnosis. The developed system is intended for information support of medical solutions in medicine using modern information technologies, in particular dose prediction. For prediction we are going to use the Tensor Flow technology. The system uses the general method of decision-making using a differential series and the analogy method. The main problems of the field of creation of medical expert systems were analyzed, and with their help the practical principle of the program part of the system was obtained. The Py Charm 2017 development environment and the Python programming language, as well as a set of the Microsoft SQL Server 2015 database management system. Computer technologies intended for the classification, diagnosis, assessment of the state, analysis of the interaction of regulatory and therapeutic processes, selection, evaluation and correction of therapeutic measures.

Received: 10 April 2018
Accepted: 31 May 2018
Published: 20 Sept 2018

RESULTS AND DISCUSSION

To date, a prototype expert system has been developed to collect information on patient diagnoses. We need this information for training our neural network, which will further advise the doctor how to treat the patient. [Fig. 1]

We have a requirement for formulation of diagnosis diabetes [1]. According to doctor formulation artificial intellect will predict dose of insulin. Doctor need to check the correctness and if it wrong, fix the answer. Then tell to machine that this answer is wrong and fit the correct solution. In this way the machine will learn. So, we need to create a self-learning neural network. We will be using Tensor Flow library for creating artificial intellect.

Tensor Flow is an open source software library for numerical computation using data flow graphs. Nodes in the graph represent mathematical operations, while the graph edges represent the multidimensional data arrays (tensors) communicated between them. The flexible architecture allows you to deploy computation to one or more CPUs or GPUs in a desktop, server, or mobile device with a single API. Tensor Flow was originally developed by researchers and engineers working on the Google Brain Team within Google's Machine Intelligence research organization for the purposes of conducting machine learning and deep neural networks research, but the system is general enough to be applicable in a wide variety of other domains as well. [2]

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ISSN: 0976-3104

Each calculation in Tensor Flow is represented as a data flow graph. It has two elements:

1. A set of tf. Operation, which represents the unit of calculation.
2. A set of tf. Tensor that represents the data units.

The forecasting model is constructed as follows [Fig. 2]

As you can see, it consists of an algorithm of machine learning, "trained" on the data. The forecasting model is formed from them, then the corresponding result is produced: [Fig. 3]

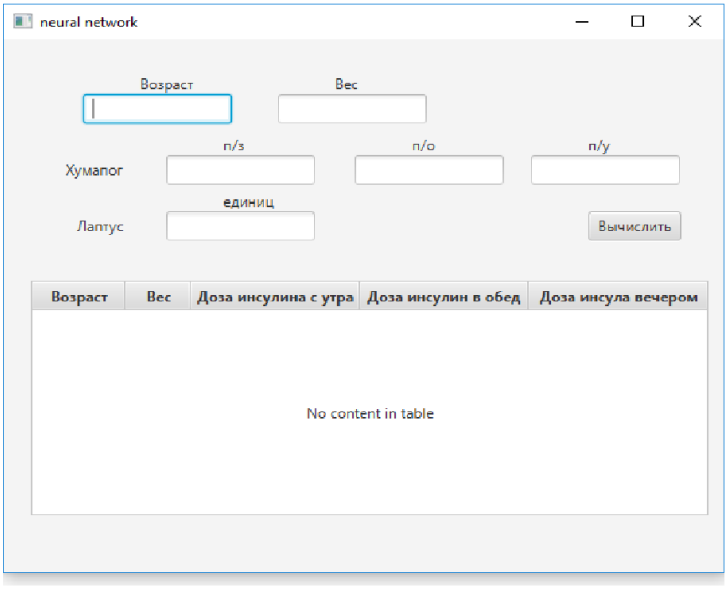

Fig. 1: A prototype expert system.

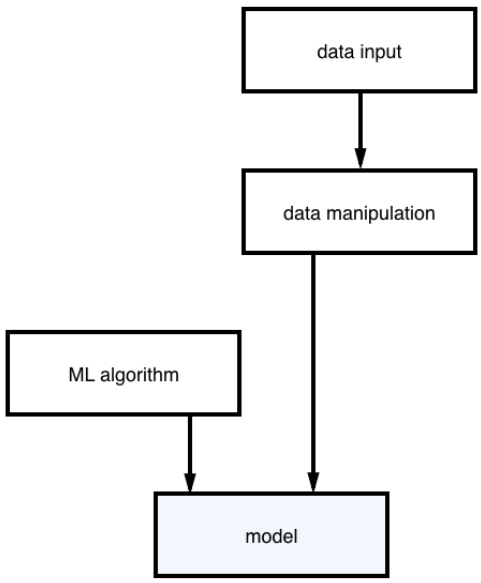

Fig. 2: The forecasting model.

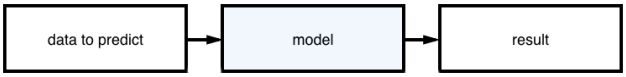

Fig. 3: The corresponding result is produced.

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The purpose of the model that we create will be to classify the data table into categories. It's means that we have information about patient, like type of diabetes, diabetic micro angiopathies, weight, height, age and etc. Then we put this information into the table and classify them. So, we will have:

- The input data: dataset of parameters of patient.
- The output data or result: dose of insulin.

We have a training data set in which all the texts are marked (each label, to which category it belongs). In machine learning, this approach is called teaching with the teacher. We classify the data into categories, therefore, this is a classification problem. To create a model, we use neural networks. [Fig. 4]

The neural network is a computational model (a way of describing the system using the mathematical language and its principles). This system is more self-learning and trained, rather than explicitly programmed. Neural networks mimic the connections of human neurons. They have connected nodes that are similar to our neurons:

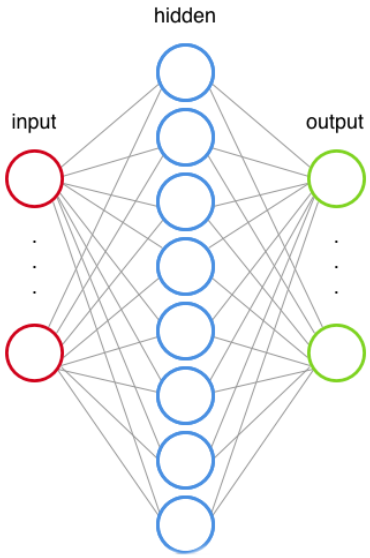

Fig. 4: The neural network.

The first neural network algorithm was the perceptron. Perceptron is the simplest neural network possible: a computational model of a single neuron. A perceptron consists of one or more inputs, a processor, and a single output. [4] [Fig. 5]

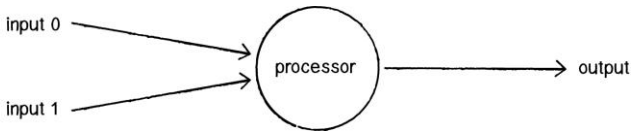

Fig. 5: The perceptron.

Our neural network will have 4 hidden layers. The task of each hidden level is to turn the input data into something that could use the output layer. [Fig. 6]

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ISSN: 0976-3104

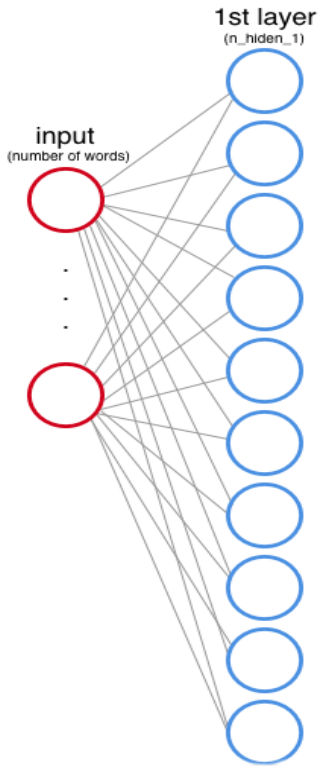

Fig. 6: The neural network.

In the input layer, one node corresponds to the element of form [Fig 6] from the data set. Each neuron is multiplied by weight, i.e. has a weight value. During the training, the neural network adjusts these indicators to produce the correct output. Further in our architecture, the data is transferred to the activation function, which determines the final output of each node. Today exists a lot of types of activation functions. We use the soft max function. In mathematics, the soft max function, or normalized exponential function is a generalization of the logistic function that "squashes" a K-dimensional vector z of arbitrary real values to a K-dimensional vector of real values in the range [0, 1] that add up to 1. The function is given by [5]:

$$\sigma(z)_j = \frac{e^{z_j}}{\sum_{k=1}^{K} e^{z_k}} \quad \text{for j = 1, ..., K.}$$

If we take an input of [1, 2, 3, 4, 1, 2, 3], the soft max of that is [0.024, 0.064, 0.175, 0.475, 0.024, 0.064, 0.175]. [5] The output has most of its weight where the '4' was in the original input. [5] This is what the function is normally used for: to highlight the largest values and suppress values which are significantly below the maximum value. [5]

The second, third, and fourth hidden layers does the same as the first, but now the input data is the output of the previous layer:

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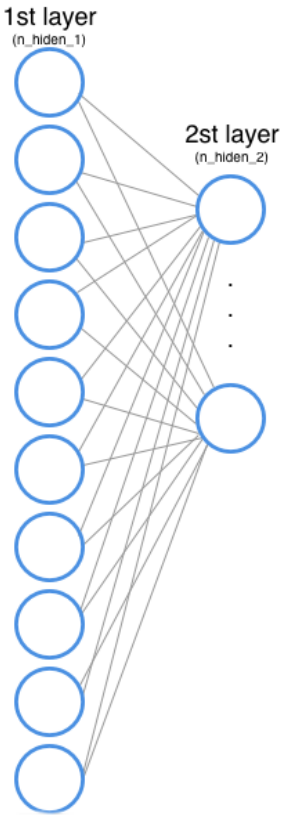

Fig. 7: The neural network.

As the previous experience has shown, the weights are updated while the network is learning. Now let's analyze the process in the Tensor Flow environment. [Fig. 7]

tf.Variable
Weights and offsets are stored in tf. Variable variables that contain a state in the graph between calls to run(). In machine learning it is customary to work with weights and offsets obtained through a normal distribution:

```
weights = {
   'h1': tf.Variable(tf.random_normal([n_input, n_hidden_1])),
   'h2': tf.Variable(tf.random_normal([n_hidden_1, n_hidden_2])),
   'out': tf.Variable(tf.random_normal([n_hidden_2, n_classes]))}

biases = {
   'b1': tf.Variable(tf.random_normal([n_hidden_1])),
   'b2': tf.Variable(tf.random_normal([n_hidden_2])),
   'out': tf.Variable(tf.random_normal([n_classes]))}
```

There are many methods how to calculate the loss. Since we are working with the problem of classification, the best way to calculate the error is cross-entropy.

We do this with TensorFlow, using the method tf.nn.softmax_cross_entropy_with_logits() (the softmax activation function), and calculate the average error tf.reduced_mean ():

```
prediction = multilayer_perceptron(input_tensor, weights, biases)

entropy_loss = tf.nn.softmax_cross_entropy_with_logits(logits=prediction, labels=output_tensor)

loss = tf.reduce_mean(entropy_loss)
```

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ISSN: 0976-3104

We want to find the best values of weights and displacements in order to minimize errors in the derivation - the difference between the obtained and the correct values. For this we use the method of gradient descent. To be more precise, it is a stochastic gradient descent: [Fig. 8].

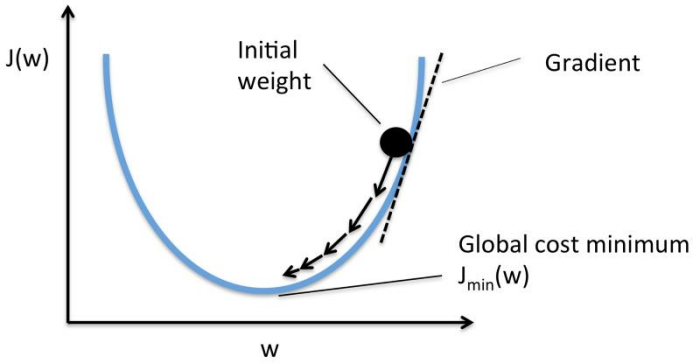

Fig. 8: The method of gradient descent.

SUMMARY

To train a neural network, we need statistical data on the management of diabetes. With their help, we can more accurately determine the course of treatment and help doctors in their work.

The open library Tensor Flow will help us very well in this. She has a huge functionality and great opportunities. It is easy to configure.

Someone may not like the fact that a person will be taught by a machine, but this is not so. She will only be the doctor's right hand. All decisions remain for him.

CONCLUSION

The prevalence of diabetes is a big problem in endocrinology. There are different stages of diabetes and various factors that affect the further treatment. For example, the norm of glucose concentration for pregnant women is less than for others. Correction of the dose of insulin should be carried out daily, taking into account the data of self-monitoring of glycemia during the day and the amount of carbohydrates in the food, to achieve individual targets for carbohydrate metabolism. Limitations in the dose of insulin do not exist. [1]

Diabetes mellitus (DM), commonly referred to as diabetes, is a group of metabolic disorders in which there are high blood sugar levels over a prolonged period. Symptoms of high blood sugar include frequent urination, increased thirst, and increased hunger. If left untreated, diabetes can cause many complications. Acute complications can include diabetic ketoacidosis, hyperosmolar hyperglycemic state, or death. Serious long-term complications include cardiovascular disease, stroke, chronic kidney disease, foot ulcers and damage to the eyes.

Diabetes is due to either the pancreas not producing enough insulin or the cells of the body not responding properly to the insulin produced. There are three main types of diabetes mellitus:

1. Type 1 DM results from the pancreas's failure to produce enough insulin. This form was previously referred to as "insulin-dependent diabetes mellitus" (IDDM) or "juvenile diabetes". The cause is unknown.

2. Type 2 DM begins with insulin resistance, a condition in which cells fail to respond to insulin properly. As the disease progresses a lack of insulin may also develop. [6] This form was previously referred to as "non-insulin-dependent diabetes mellitus" (NIDDM) or "adult-onset diabetes". The most common cause is excessive body weight and insufficient exercise.

3. Gestational diabetes is the third main form, and occurs when pregnant women without a previous history of diabetes develop high blood sugar levels.

Prevention and treatment involve maintaining a healthy diet, regular physical exercise, a normal body weight, and avoiding use of tobacco. Control of blood pressure and maintaining proper foot care are important for people with the disease. Type 1 DM must be managed with insulin injections. Type 2 DM may

ISSN: 0976-3104

be treated with medications with or without insulin. Insulin and some oral medications can cause low blood sugar. [8] Weight loss surgery in those with obesity is sometimes an effective measure in those with type 2 DM.[7] Gestational diabetes usually resolves after the birth of the baby.[9]

CONFLICT OF INTEREST

There is no conflict of interest.

ACKNOWLEDGEMENTS

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

FINANCIAL DISCLOSURE

None

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