Description for the general public

We live in an era of information overload. Data describing various phenomena and dependencies are available at your fingertips. Their acquisition and collection is not a major problem with the growing capacity of database systems and computing power of computers. The challenge is to extract useful knowledge from this data, which will allow us to quickly diagnose the patient, develop a company's strategy, recognize the image from the camera or forecast the weather. In all these cases of data mining the tools of statistics and machine learning are used. Artificial neural networks are among the most popular methods of machine learning and are widely used for the construction of decision systems, image recognition, modeling of physical phenomena, forecasting and control. They acquire knowledge from data in the learning process and remember it in their internal parameters - synaptic weights. However, due to the layered structure of neural networks, the learning process is complicated, it is inefficient and does not always lead to good results. Neural network learning algorithms are based on gradient methods that are time-consuming, sensitive to initial parameter values, and converge to the local minima of the target functions instead of the global ones.

In recent years, alternative methods of learning neural networks have been intensively developed, so-called randomized methods, in which the weights of neurons in the inner layer of the network (hidden layer) are selected randomly, and weights in the output layer are determined using simple matrix transformations. This approach leads to the simplification in implementation and allows several hundred times to reduce the learning time keeping the modeling accuracy. Many researchers using randomized learning methods pay attention to the proper way of generating random weights: when weights are drawn from the wrong range, modeling results are much worse. However, there is no indication in the literature on how to properly generate weights.

In this project, it is planned to develop new methods for generating random parameters of neural networks. On the basis of theoretical studies on the function approximation and construction the approximation curve by aggregating the activation functions of neurons, the formulas for calculating the activation function parameters will be derived. The activation functions will be arranged in space in such a way that their most non-linear fragments are inserted in the areas filled with data. This will allow us to effectively model strongly non-linear relationships with high accuracy, with the maximum use of resources (with currently used randomized learning methods, many neurons do not participate in modeling, because their activation functions have saturation in regions filled with data and are therefore unsuitable for modeling nonlinear relationships). The result of the research will be new algorithms for generating random parameters of neural networks for regression and classification problems. They will improve the accuracy of modeling and generalization.