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THE PRINCIPLE OF OPERATION OF THE PERCEPTRON AND ITS APPLICATIONS.

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Annotation. *The article presents the algorithm of operation of the perceptron, the necessary conditions and technical aspects for its correct operation. It also considers its application in various fields such as machine learning, classification, face recognition, and handwritten digit recognition. The perceptron is the basis for the development of modern artificial intelligence systems and is important as one of the main elements of deep learning.*

Key words: *Perceptron, artificial neuron, working principle, analysis, neural network, input signal, output signal, linear separation problems, optimization, decision making, algorithm, machine learning, classification, face recognition, artificial intelligence.*

Аннотация. *В статье представлен алгоритм работы персептрона, необходимые условия и технические аспекты для его корректной работы. Его также рассматривали для применения в различных областях, таких как машинное обучение, классификация, распознавание лиц и распознавание рукописных цифр. Персептрон имеет основополагающее значение для разработки современных систем искусственного интеллекта и является одним из ключевых элементов глубокого обучения.*

Ключевые слова: *персептрон, искусственный нейрон, принцип работы, анализ, нейронная сеть, входной сигнал, выходной сигнал, задачи линейного разделения, оптимизация, принятие решений, алгоритм, машинное обучение, классификация, распознавание лиц, искусственный интеллект.*

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A perceptron is one of the simplest and earliest forms of artificial neural networks, which has been the basis for the development of many machine learning and artificial intelligence systems. The perceptron model was developed by Frank Rosenblatt in the 1950s and was used to solve classification problems. Today, the foundations of the perceptron have paved the way for the development of more complex artificial neural networks and deep learning algorithms. This article will analyze in detail the working principle of the perceptron, its structure and operation, as well as its applications in the real world.

Working principle of the perceptron. A perceptron is actually a very simple neural model, the main task of which is to convert inputs into output values. The working principle of the perceptron consists of the following main parts:

Inputs: The perceptron accepts several input signals. Each input represents a feature or attribute and is usually denoted as x1, x2, ..., xn. For example, in a classification problem, each input can be a feature that needs to be classified (e.g., the pixel values of an image).

Weights: The importance of each input, or how much it influences the model, is determined by a weight. Weights are constant values that affect the inputs and are optimized as the model learns. The weights are represented as w1, w2, ..., wn.

Summation: Each input and its corresponding weight are multiplied, and then the results are summed. That is, the output of the perceptron is calculated as:

$$z = \omega_1 x_1 + \omega_2 x_2 + \cdots + \omega_n x_n + b$$

Here b is a bias (a parameter that changes the overall effect of the inputs) that is added to the model so that the system becomes more flexible.

Activation Function: Depending on the input, the perceptron will only produce two outputs: that is, it will only produce values of 0 or 1. This process is done through the activation function. The simplest activation function is the signum function, which takes a value and converts it to 0 or 1:

$$y = \begin{cases} 1 \; agar \; z \geq 0 \\ 0 \; agar \; z < 0 \end{cases}$$

This activation function allows the perceptron to perform the classification task.

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Perceptron training process. The perceptron training process is based on optimizing the variables. The main goal of the model is to correctly classify the output by updating the weights and changing the bias. The gradient descent algorithm is used in the perceptron training process, that is, it calculates how much the model's output deviates from the true response and updates the weights to minimize this error.

Applications of the perceptron. Although the perceptron is a simple and effective model, it is used only to solve linear classification problems. Linear separation is the process of finding a single straight line that separates a data set into two groups. Perceptrons are mainly used in the following areas:

Classification. Perceptrons are mainly used in classification problems. For example, image recognition, separating emails into spam and non-spam, etc. Perceptrons cannot perform more than two classes, but this makes them very efficient and fast.

Handwritten digit recognition. Perceptrons were used in many early handwritten digit recognition systems. Each pixel of the digits to be classified is used to feed the perceptron model. The model then learns the weights needed to classify the digit.

Use in simple networks. Perceptrons are particularly well suited for working on small and simple systems. For its effective use, it is important that the classes and inputs of the model are clear and simple. In addition, the fast performance of the perceptron allows it to be used in fast decision-making systems.

User Behavior Detection. Perceptron models can also be used in some applications, such as generating recommendations based on user choices. Perceptrons can be used to solve classification problems based on the user's previous decisions.

Limitations of the Perceptron. One of the main limitations of the perceptron is that it can only solve linear classification problems. This means that if the data set has a complex geometric shape that can be divided into multiple classes, the perceptron cannot solve this problem. However, complex systems such as deep learning systems and multilayer neural networks help to overcome this limitation.

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The perceptron is one of the first models in the field of artificial intelligence and machine learning, and its working principle and foundations have been the basis for the development of modern systems today. The perceptron is a simple and effective model, which is mainly used to solve classification problems. Although it is used only for linear classification, its training process and working principle paved the way for the basic concepts of deep learning and played an important role in the development of artificial intelligence systems.

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