An example of the use of an artificial neural network in problems of experimental physics

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Abstract. Artificial neural networks (ANN) are a powerful tool for processing data and solving complex problems in various fields of science and technology. For example, the application of neural networks in high-energy and experimental physics is a cutting-edge area. With the ability to learn from large amounts of data and identify complex dependencies, neural networks provide unique capabilities for analyzing particle trajectories, their interactions, and identification. One of tasks is to determine the trajectories of particles passing through the detectors, which is important for understanding the fundamental physical processes in colliders. Traditional particle tracking methods often face challenges due to the large amount of data and noise in experimental measurements. Deep learning neural networks offer a solution to these problems by providing high accuracy and efficiency in data processing. Neural networks can learn to recognize patterns in data that a human analyst might not notice. In the context of particle tracking, this means automatically identifying particle trajectories, classifying them, and predicting future behavior. This is especially useful when dealing with rare events and analyzing interactions where traditional methods may not be effective. However, the use of neural networks also poses a number of problems. Training models requires large amounts of data and computing resources. In addition, interpreting the results obtained using neural networks can be difficult due to the so-called "black box" effect. Despite these challenges, the potential of neural networks in particle tracking is enormous. The study conducts an experiment to classify points in a given area using ANN. The study reproduces the experiment of Professor G.A. Ososkov (Joint Institute for Nuclear Research, JINR), illustrating the basic aspects of the behavior of elementary particles when passing through collider detectors [1]. The experimental setup simulates the process of particle registration, and the neural network is trained to distinguish between their types based on interaction with sensors. To train the ANN, the BackProp error backpropagation algorithm is used [2]. The results demonstrate the effectiveness of machine learning methods in high energy physics. In the experiment, the model is trained on a sample of only a thousand points, but demonstrates good performance due to the simplicity of the problem under consideration.

Keywords: Artificial neural networks · Tracking · Classification · Physics · Machine learning

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