28th International Scientific Conference of Young Scientists and Specialists (AYSS-2024)

Contribution ID: **1710** Type: **Oral**

Search for the low-energy state of the ising model using neural networks

Tuesday 29 October 2024 16:45 (15 minutes)

In this paper, the Ising model, a classical model of statistical mechanics, is investigated in order to determine its ground (low-energy) state at fixed random interaction constants J and variable direction of spins in the spin lattice. A new algorithm based on a self-learning bilayer neural network implemented on the Keras library is proposed and investigated to efficiently find the ground state of the Ising model.
The network training algorithm consists of predicting possible spin lattice configurations, flipping the spins to minimise the energy of the system and training the neural network based on the obtained data. Numerical experiments have been performed for different spin lattice sizes and J values. The obtained results demonstrate the comparative efficiency of the proposed algorithm in finding the ground state of the Ising model.
In existing studies, convolutional neural networks that perform clustering of spin lattices were used to solve this problem, which allowed increasing the size of the analysed systems, overcoming the limitations associated with computational complexity. Neural networks capable of recovering the temperature of a system based on its spin configuration have also been studied. However, the Metropolis algorithm, known for its tendency to capture local energy minima, was used as a method to find the ground state, which can lead to inaccuracy in determining the true ground state.
The proposed algorithm, based on a self-learning neural network, is a promising method for determining the ground state of the Ising model. In the future, it is planned to extend the model to more complex systems, as well as to increase the size of the spin lattice for a deeper investigation of the behaviour of systems with different characteristics.

Primary author: ТЕРНОВОЙ, Никита (FEFU)

Co-authors: Mr АНИСИЧ, Александр (FEFU); Mr ЧЕРКАСОВ, Михаил (FEFU); Ms ЛОБАНОВА, Элиза (FEFU)

Presenter: ТЕРНОВОЙ, Никита (FEFU)

Session Classification: Theoretical Physics

Track Classification: Theoretical Physics