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Original Article

Applications of Blockchain Technology in Modern Power Systems

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Abstract: *In the context of modern power system development to support the evolution towards green energy and carbon-neutral emission goals, many existing problems and even challenges demand new technical solutions. In recent years, decentralized blockchain technology has been employed to address some problems in power systems, and many papers have been published. In this paper, the concept of blockchain is first introduced. A brief survey of the existing publications regarding the applications of blockchain in power systems, including power system dispatching, microgrid operation, energy trading, electricity trading settlement, transmission, and distribution system operation, is then carried out. In addition, several application scenarios of blockchain technology in power systems are also introduced. Through the discussion, we found that we still need to weigh the advantages and disadvantages, overcome its leakage, and bring its value into play if we apply blockchain technology in modern power systems in support of zero carbon goals.*

Keywords: *Blockchain Technology, Power System, Deep Neural Network (DNN).*

I. INTRODUCTION

It has been pointed out in that power industry restructuring should be promoted, and the market-dominant position of the incremental distribution grid, microgrid, and distributed power supply, which is helpful for accommodating renewable energy generation, should be established.

Under the premise of the call for a dual carbon target, a high proportion of new energy is connected to the power grid in China, which leads to the security and stability of power system is affected. For example, replacing the conventional units with large-scale wind and solar power generation will reduce the overall effective inertia and the anti-disturbance capability of the system. In addition, it will require the power grid to bear a heavy power flow pressure, making frequency control more difficult compared to many other systems. Due to the large-scale off-grid system of wind power and photovoltaic generator, serious cascading failures and a large number of applications of the power electronic devices increase the risk of sub-synchronous oscillation. Therefore, the functional orientation and characteristics of each link in the modern power system will need to be greatly adjusted. The development of the system will also face many problems and even challenges that need to be solved. In order to promote the accommodation of the new energy system, reduce the proportion of abandoned wind and light, and improve the coordination ability of the distributed energy and power grids, decentralized management will play an important role in future power systems.

II. SYSTEM IMPLEMENTATION

A. Existing system

- Enhance the existing power grid infrastructure by integrating blockchain for secure and transparent information exchange among grid participants.
- Utilize blockchain to create a transparent and immutable ledger for tracking the generation, consumption, and trading of renewable energy credits.

B. Proposed System

- Implement a blockchain-based decentralized energy trading platform where consumers can buy and sell excess energy directly with each other.
- Use DNN to predict energy demand and supply patterns, optimizing trading strategies and predicting future prices for more efficient transactions.
- Enhance the security of power systems by using blockchain for secure and tamper-resistant storage of critical data.

C. Deep Neural Network (DNN)

- A deep neural network (DNN) is an ANN with multiple hidden layers between the input and output layers. Similar to shallow ANNs, DNNs can model complex non-linear relationships.

- The main purpose of a neural network is to receive a set of inputs, perform progressively complex calculations on them, and give output to solve real world problems like classification. We restrict ourselves to feed forward neural networks.
- We have an input, an output, and a flow of sequential data in a deep network.

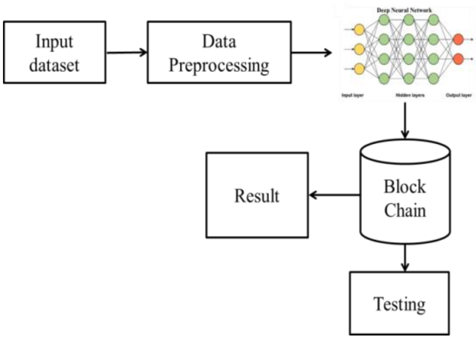

Figure 1: Proposed Diagram

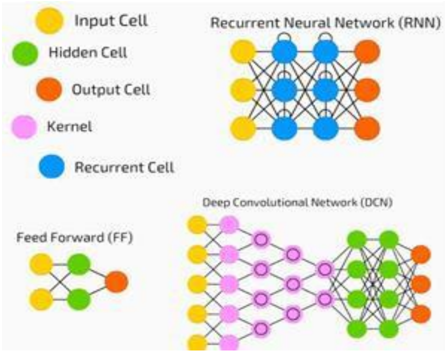

Figure 2: Deep Neural Network (DNN)

- Neural networks are widely used in supervised learning and reinforcement learning problems. These networks are based on a set of layers connected to each other.
- In deep learning, the number of hidden layers, mostly non-linear, can be large; say about 1000 layers.
- DL models produce much better results than normal ML networks.
- We mostly use the gradient descent method for optimizing the network and minimising the loss function.
- We can use the **Imagenet**, a repository of millions of digital images to classify a dataset into categories like cats and dogs. DL nets are increasingly used for dynamic images apart from static ones and for time series and text analysis.
- Training the data sets forms an important part of Deep Learning models. In addition, Backpropagation is the main algorithm in training DL models.
- DL deals with training large neural networks with complex input output transformations.
- One example of DL is the mapping of a photo to the name of the person(s) in photo as they do on social networks and describing a picture with a phrase is another recent application of DL.

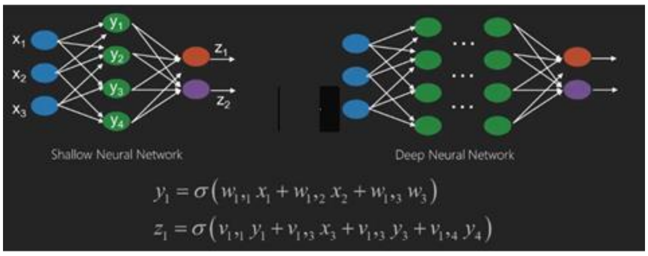

Figure 3: Neural Networks Functions

Neural networks are functions that have inputs like x1,x2,x3...that are transformed to outputs like z1,z2,z3 and so on in two (shallow networks) or several intermediate operations also called layers (deep networks).

The weights and biases change from layer to layer. 'w' and 'v' are the weights or synapses of layers of the neural networks.

The best use case of deep learning is the supervised learning problem.Here,we have large set of data inputs with a desired set of outputs.

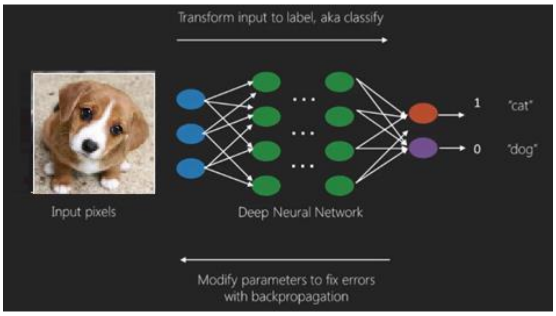

Figure 4: Propagation Algorithm

- Here we apply back propagation algorithm to get correct output prediction.
- The most basic data set of deep learning is the MNIST, a dataset of handwritten digits.
- We can train deep a Convolutional Neural Network with Keras to classify images of handwritten digits from this dataset.
- The firing or activation of a neural net classifier produces a score. For example,to classify patients as sick and healthy,we consider parameters such as height, weight and body temperature, blood pressure etc.
- A high score means patient is sick and a low score means he is healthy.
- Each node in output and hidden layers has its own classifiers. The input layer takes inputs and passes on its scores to the next hidden layer for further activation and this goes on till the output is reached.
- This progress from input to output from left to right in the forward direction is called **forward propagation.**
- Credit assignment path (CAP) in a neural network is the series of transformations starting from the input to the output. CAPs elaborate probable causal connections between the input and the output.
- CAP depth for a given feed forward neural network or the CAP depth is the number of hidden layers plus one as the output layer is included. For recurrent neural networks, where a signal may propagate through a layer several times, the CAP depth can be potentially limitless.

III. RESULT

Figure 5: Matrix

Figure 6: Training Epochs

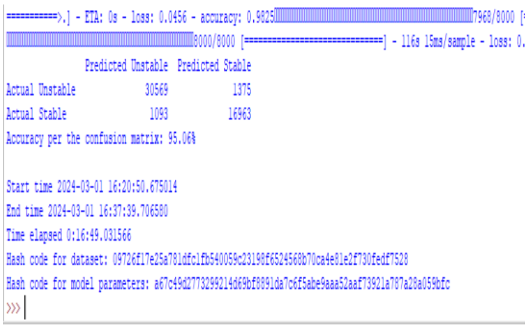

Figure 7: Training Results

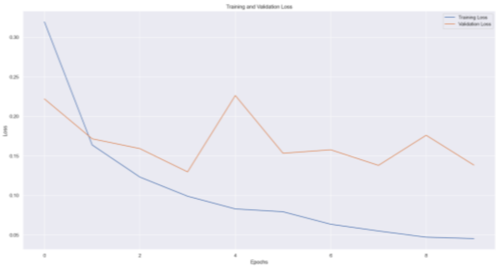

Figure 8: Training and Validation Loss

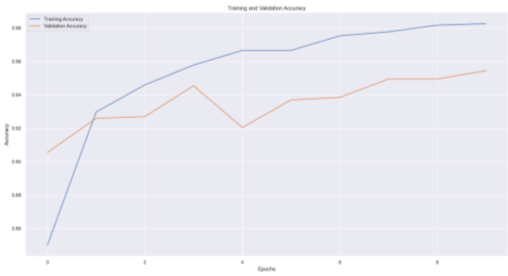

Figure 9: Training and Validation Accuracy

IV. CONCLUSION

This project mainly discussed the application of five scenarios on blockchain technology in modern power system, aiming to analyze the current research status of blockchain technology in the power system and provide research directions for researchers. Naturally, the innovative application of blockchain technology goes beyond the scenarios mentioned in this article. Studies have also been performed on power enterprise management virtual power plant, new energy storage, new two-way interaction of load, etc. In the future, it will also play an important role in the field of ecological energy, cross-chain transparent power systems, power market trust mechanisms, and so on. Through the above discussion, we find that we still need to conduct in-depth research on blockchain technology. It is suggested that advantages and disadvantages should be weighed in various aspects during design and application. In the future, we hope to overcome obstacles, develop advantages, and improve the defects of blockchain technology in modern power systems.

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