

Supporting Information

Comparison of Multi-step Prediction Models for Voltage Difference of Energy Storage Battery Pack Based on Unified Computing Operation Platform

Weisen ZHAO,^{a,b} Jinsong WANG,^c Peng LIU,^b Dazhong WANG,^b Lanfang LIU^b and Xiangjun LI^{b,*}

^a School of Electrical Engineering and Automation, Hefei University of Technology, No. 193 Tunxi Road, Hefei, Anhui 230009, China;

^b China Electric Power Research Institute, No. 15 Xiaoying East Road, Qinghe, Beijing 100192, China;

^c Case School of Engineering, Case Western Reserve University, 10900 Euclid Ave, Cleveland, Ohio 44106, USA.

* Corresponding author: li_xiangjun@126.com

Table of Contents

1. Model Training and Verification Based on Unified Computing Operation Platform	S2
2. Software Module Development and Application	S3

1. Model Training and Verification Based on Unified Computing Operation Platform

The Unified Computing Operation Platform(UCOP) is an enterprise-level digital transformation support service platform created by China Electric Power Research Institute(CEPRI) in compliance with the overall digital transformation framework of the State Grid Corporation of China and combined with China Electric Power Research Institute's corporate positioning and business characteristics. Through the overall management of the company's digital resources, the platform integrates various common technical components such as big data, artificial intelligence, and the Internet of Things to achieve comprehensive online digital support services and promote the construction of a central platform for data, business, and technology. For the digital construction of CEPRI to provide "safe and reliable, service sharing, extensive integration, independent and controllable" digital infrastructure. Empowering our institute's scientific research, experimental testing, technical services and other businesses to realize data value and intelligent business development. Provide strong support for our institute to build a national strategic scientific and technological force in the field of energy and power. Among them, the big data service cluster has 58 nodes, a total of 2776 CPU cores, a total memory of 13.59TB, and a total storage of 2.82PB. The artificial intelligence service cluster has 30 GPU servers and 96 GPU cards.

All algorithm models in this article are deployed on the Unified Computing Operation Platform(UCOP), and all related model training and testing work is completed efficiently. Specifically including the following work:

(1) Data storage and transmission: Prepare data sets for training and testing, and complete data collection, cleaning, annotation, and storage. Ensure that the data quality and transmission efficiency of the data set meet the needs of model training and testing.

(2) Select the model training framework: In this article, Python is used as the programming language, and the model training frameworks used include TensorFlow, statsmodel, sklearn, etc., and the data processing and statistical toolkits used are numpy, pandas, etc.

(3) Create a virtual machine instance: Create a virtual machine instance on the Unified Computing Operation Platform(UCOP) to run model training and testing

tasks. The instance created in this article is a GPU instance, which can call GPU computing resources to improve the speed and performance of model training.

(4) Configure the running environment: Install the model training framework, dependent libraries and necessary tools on the virtual machine instance. And adjust the correct environment configuration for various types of models to run smoothly.

(5) Model training: Use the selected model training framework to train the model on a virtual machine instance. And configure training parameters, optimization algorithms, etc. to optimize the model.

(6) Model testing: After the model training is completed, the model is evaluated using test data. And use different evaluation metrics to measure the performance of the model.

(7) Adjustment and optimization: Adjust and optimize the model based on test results. Including improving data sets, adjusting model architecture, hyperparameter tuning, etc.

(8) Deploy the model: After the model passing all aspects of testing and meeting the requirements, deploy the model to the production environment so that it can be called at any time in actual applications.

(9) Monitoring and Maintenance: The performance of the model is regularly monitored, and the model is maintained and updated in time as needed.

(10) Security: Ensure the security of data and models, taking appropriate security measures to protect sensitive information.

The uniqueness of our research is that it utilizes Unified Computing Operation Platform (UCOP) for model training and verification, providing a standardized environment for model training and evaluation. We believe this approach enhances the reproducibility and comparability of the prediction results from different models.

2. Software Module Development and Application

According to the voltage difference prediction model of energy storage battery pack studied in this paper, a software module of voltage difference over limit fault prediction of energy storage battery pack is developed and packaged into an API interface. The dependent environment and source code of the model are packaged into docker files, which can provide one-click deployment and API interface call services.

The software modules of voltage difference over-limit fault prediction for energy storage battery pack have been deployed and applied in many digital platforms in China, among which the two most important platforms are as follows:

1. Unified Computing Operation Platform (UCOP). For specific details of UCOP, please read Section1 of Supporting Information.
2. National Safety Monitoring Information Platform for Electrochemical Energy Storage Power Station. Led by the China Electricity Council, it is jointly constructed by 19 members of the National Electricity Safety Production Committee, including the State Grid Corporation of China, China Southern Power Grid, and China Huaneng, etc.