Implementation of Deep Learning Algorithm on Personal Big Data Platform for Engineering Applications

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Introduction

The engineering-based, personal AI and big data platform, together with its VM system, has been built to support users to quickly establish a working software program for data analyses. The platform applies a master-slave distributed architecture to deal with a large amount of data and offers sample codes of engineering applications using deep learning algorithms.

We first selected the Fuhai wind farm as a study site and utilized the personal AI and big data platform to assist offshore wind energy research, including wind field prediction and wind turbine bearing monitoring, optimizing path planning for shipping, and adopting the multi-scale weather, wave, current simulation systems to provide high-resolution forecasting data.

Objectives:

- Rebuilding the past 5-year weather and marine database and providing the future 3-day high-accuracy forecast of wind, wave, current information.
- Utilizing AI/BD technologies to assist the offshore wind energy industry to lower the cost or improve efficiency of wind power generation during the plan, construction, service and maintenance stages.
- Assisting researchers and developers to apply AI/BD implementations easily and efficiently on the platform.

Development of personal and movable AI/BD integration computing platform

The engineering-based, personal big data platform, usually covering only 4 data nodes, with its 1+3 VM (Virtual Machine) system can be used for education and training. Specifically, the 1+3 physical cluster system allows users to quickly deploy applications. The small big data system is very beneficial for student training in laboratories and for R&D at small-scale enterprises with confidential or sensitive data.

The platform applies a master-slave distributed architecture to deal with a large amount of data and introduces the latest distributed deep learning technique (TensorflowOnSpark) to greatly improve the computing efficiency. Thus, users can avoid end-to-end learning latency due to transferring large datasets between separate clusters.

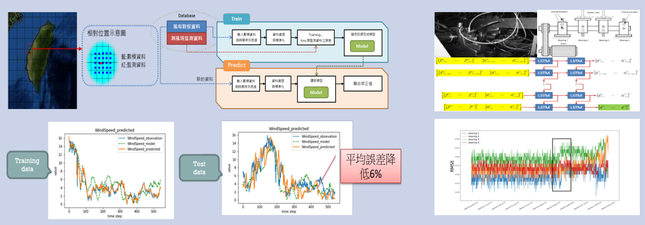
Deep Learning Algorithm on Personal Big Data Platform

Both TensorFlow and Keras, the deep learning frameworks, have been pre-installed and configured on the platform to run on GPUs. We offer the code samples applying these frameworks, such as image recognition for cats and dogs, time-series prediction for electric power consumption, video generation or classification on real-world sequences using deep learning models – CNN, RNN, ConvLSTM, respectively for rapid prototyping. Hence, researchers and developers are able to utilize and optimize their models easily on the platform for different implementations. Besides, for an ongoing video generation project, a conditional generative adversarial net (cGAN) has been developed and utilized to predict more accurate future video image sequences. Thus, such as the example of typhoon tracking will soon be included on the platform as well.

Innovative applications of the big data of offshore wind energy in Taiwan

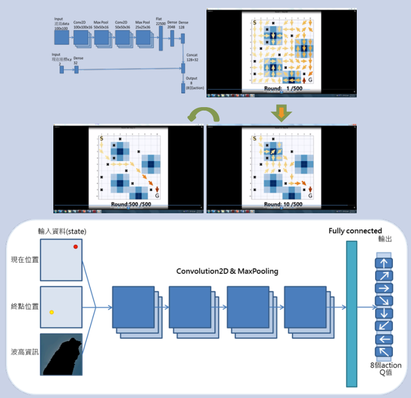
Deep learning implementation for wind field prediction and wind turbine bearing monitoring

- Building the deep learning RNN-LSTM model with the offshore wind monitoring data and the wind forecast data to provide a single synthesized wind forecast with the possible best accuracy.
- Establishing a RNN-based bearing health monitoring approach, which is validated with the NASA prognostics data, to be capable of monitoring the bearing health of wind turbines.



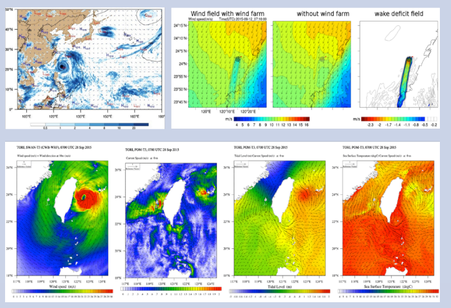
Reinforcement learning implementation for optimized path planning for shipping

Building the Deep Q-Network model for the optimized path planning for shipping based on the ocean information grid maps around Taiwan, which are generated by the marine simulation data.



Taiwan offshore wind energy (weather and marine) BD database establishment

- Adopting the multi-scale weather, wave, current simulation systems to provide high-resolution forecasting data for the wind energy industry.
- Establishing the distributed/parallel AI/BD integration computing platform (Hadoop/ Spark/Hbase) to accommodate the big simulation data and support the BD/AI analytics.



Future Development and Acknowledgement:

The current deep learning algorithm has been successfully implemented in the personal big data platform for two engineering applications. More deep learning technologies such as GAN and RL, will be implemented in the newly developed high-efficiency, personal big data/AI integrated platform for green-energy and other engineering applications. This current research is financially supported by Ministry of Science and Technology with contract from June 1, 2017 to May 31, 2020, Grant No. MOST 106-3114-E-492-003.