Evaluation of weather forecast with DL

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I. Introduction

This section is based on [1]. Due to its impact on human existence worldwide, weather forecasting has drawn the interest among several scholars from different research fields. Many studies have been driven to investigate hidden patterns in the vast dataset for weather prediction because of the increasing prevalence of vast weather observation data nowadays and the development of computer and information technologies in the past ten years. Flight navigation, cultivation, and tourism are just a few of the many possible uses for weather forecasting, making it a captivating research problem. Among the problems of weather forecasting are learning weather interpretation using a vast volume of weather dataset and constructing an effective weather prediction model that utilizes latent patterns and structures in the huge quantity of weather dataset.

Major efforts have been made in weather forecasting in the past ten years, utilizing statistical modeling approaches, particularly machine learning, with favourable outcomes.

Deep learning neural networks (NNs) have more layers than ”shallow” ones employed in conventional machine learning models, as indicated by the term ”deep” in the phrase. After successfully implementing the layer-wise unsupervised pre-training methodology that is used to effectively address the training challenges, this multi-layer NN has attracted significant research interest. When compared to shallow models, the ”deep” architecture is crucially significant since NN with deep architecture can offer superior learning capabilities.

Deep learning is implemented in weather representation and modeling as a result of its effectiveness in several domains, as documented by several researchers. For instance, a new study suggests [2] utilizing deep neural networks (DNN) to learn hierarchical features from a significant amount of weather data to describe the weather. [1]

II. Weather Forecasting Problem

In the last decade, many significant efforts to solve weather forecasting problem using statistical modeling including machine learning techniques have been reported with successful results. Input data for weather forecasting is high-dimensional weather time series data which are collected from a number of weather stations from various regions. The study of Recurrent NN models to forecast regional annual runoff. The study by Chen and Hwang proposes a fuzzy time series model for temperature prediction based on the historical data that are represented by linguistic values. The other study has shown that ensemble of artificial neural networks (ANNs) successfully learns weather patterns based on weather parameters. NN for rainfall forecasting using statistical downscaling. Other research proposes a Chaotic Oscillatory-based Neural Network for short term wind forecasting using LIDAR Data. A long term rainfall forecasting model using Integrated ANN and fuzzy logic wavelet model[IO]. The research with the precipitation index drought forecasting using NN, wavelet NN, and Support Vector Regression (SVR). Rainfall forecasting model based on an ensemble of artificial NN[1].

III. Deep learning in weather research

The increased computational power, the availability of large datasets, and the rapid development of new NN architectures all contribute to the ongoing success of DL. Some of these new NN can solve certain ML tasks much more efficiently than the classical fully connected, feed-forward networks. One especially successful concept, which has been widely applied, is convolutional neural networks (CNN), where a stack of small-sized filters with few trainable parameters is applied to images or other gridded data to extract coarser scale features. CNNs have been used in weather and climate applications, where the NN was trained to recognize spatial features, for example in the analysis of satellite imagery or weather model output.

The family of recurrent neural networks (RNN) was designed specifically for the learning of time-dependent features (i.e. text and speech recognition). More advanced RNN architectures are long short-term memory (LSTM) nodes and gated recurrent units (GRU, [45]). LSTM and GRU cells can be embedded in more complex neural network architectures. For example, the combination of a normal CNN with LSTM yields the so-called ConvLSTM network[1].

IV. Challenges of end-to-end deep learning weather prediction

V. Data preparation and model evaluation

A. Physical constraints and consistency

B. Conclusion

References

References

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[2] J. N. K. Liu, Y. Hu, Y. He, P. W. Chan and L. Lai, ”Deep Neural Network Modeling for Big Data Weather Forecasting”, pp. 389-408, 2015.