Regression Analysis on Weather Data Using Deep Neural Networks

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***Abstract*—Weather forecasting plays a critical role in various sectors, from agriculture and transportation to energy management and public safety. Accurate temperature prediction is particularly important for these applications. While traditional statistical models have been employed for weather forecasting, deep learning offers a powerful alternative for capturing complex patterns and non-linear relationships within meteorological data. This paper investigates the application of deep neural networks for predicting average daily temperature. We utilize a dataset of historical weather data, including factors like humidity, wind speed, pressure, and previous temperature readings. We experiment with Deep Neural Networks (DNNs), to determine the optimal model for our specific application. The performance of the models is evaluated using metrics such as mean absolute error (MAE), root mean squared error (RMSE), etc. Our findings demonstrate that deep learning models can achieve high accuracy in predicting average daily temperature, surpassing traditional methods in certain cases. The results provide valuable insights into the potential of deep learning for improving weather forecasting capabilities.**

***Index Terms*—Weather Forecasting, NN, Neural Networks, Deep Learning, Regression Analysis**

I. Motivation

Accurate weather forecasting is crucial for countless sectors, but traditional methods often struggle to capture the complex, non-linear dynamics within atmospheric data, leading to less accurate predictions, especially over longer timeframes. Deep learning, with its ability to learn intricate patterns from massive datasets, offers a promising solution. By leveraging the power of deep neural networks (DNNs), we aim to achieve more precise forecasts, better handle non-linear relationships, and potentially enable real-time updates. This research explores the potential of deep learning to significantly improve weather forecasting accuracy, thereby supporting more reliable and informed decision-making across critical sectors.

II. Literature Review

[1] This paper investigates the use of deep learning for stock market prediction, arguing that traditional machine learning methods often fail to capture the complex and non-linear nature of financial data. The authors propose a deep learning-based non-linear regression model and demonstrate its effectiveness in predicting stock prices compared to linear regression and other existing approaches. The model is tested on two publicly available datasets, the Tesla Stock Price and New York Stock Exchange data, showing promising results.

[2] This paper investigates the use of machine learning and deep learning techniques to predict agricultural yields in India. The authors compare the performance of various algorithms, including decision trees, random forest, XGBoost regression, convolutional neural networks (CNN), and long short-term memory networks (LSTM), using a dataset comprised of historical agricultural data from India. The study finds that random forest and CNN models demonstrate the highest accuracy in predicting yield, highlighting the potential of these techniques for supporting farmers and improving food security.

[3] This paper explores the use of deep learning for predicting student academic performance. The authors compare a deep learning-based regression model with traditional linear regression, using a dataset of student records from three colleges in Assam, India. The deep learning model outperforms the linear regression model in terms of mean absolute error and loss, suggesting its potential for more accurate prediction of student performance. The study demonstrates that deep learning can be effectively applied to smaller educational datasets, potentially aiding in identifying at-risk students and providing timely interventions.

[4] This paper explores the use of machine learning and deep learning regression frameworks to accurately predict dielectrophoretic (DEP) force on microparticles in a textile electrode-based DEP sensing device. The researchers trained and compared various machine learning models (KNN, SVM, Random Forest, Neural Networks, Linear Regression) and deep learning models (CNN architectures of AlexNet, ResNet-50, MobileNetV2, and GoogLeNet) using images of pearl chain alignment at varying input voltages. ResNet-50 with RMSPROP optimizer exhibited the best performance for yeast cells, while AlexNet with ADAM optimizer performed best for polystyrene microbeads, demonstrating the potential for deep learning in DEP-aided Lab-on-Chip devices.

III. Methodology

Our approach to regression analysis on Weather data involves a systematic process that includes data preprocessing and the application of deep neural network to predict the average temperature. The following steps outline the methodology adopted for this study:

A. Data Preprocessing

- Removing Unnecessary Features: The first step involved removing unnecessary features from the data. We removed date and events features.
- Normalizing: Normalizing is crucial for better model performance. Min-Max scaling was used to normalize the data.

B. Model

- Deep Neural Network (DNN): RNNs are a class of neural networks well-suited for sequential data. We implemented a standard RNN model to capture the temporal dependencies in the Bangla text data. Despite their effectiveness in handling sequences, RNNs can struggle with long-term dependencies due to vanishing gradient problems.

C. Model Training and Evaluation

The preprocessed data was fed into the Neural Network model. We evaluated the performance of the model using standard metrics such as MAE, MSE, RMSE, RMSLE.

IV. Result Analysis

These results were achieved after fine-tuning the parameters of the models. The Training loss curve is shown in figure 1.

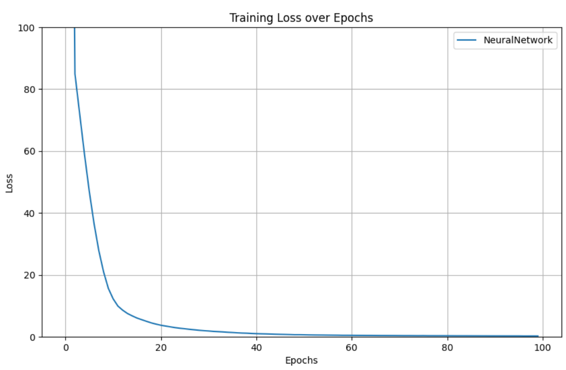

Fig. 1. Training Loss of DL models

The MAE, MSE, RMSE and RMSLE of the neural network are shown in table I.

TABLE I
Performance of Neural Network

Model	MAE	MSE	RMSE	RMSLE
DNN	0.1747	0.3249	0.4180	0.0065

The results achieved show that Neural Network can very accuractely predict average temperatures.

References

[1] Agrawal, S. C. (2021). Deep learning based non-linear regression for stock prediction. IOP Conference Series: Materials Science and Engineering, 1116, 012189.

[2] Sharma, P., Dadheech, P., Aneja, N., Aneja, S. (2023). Predicting Agriculture Yields Based on Machine Learning Using Regression and Deep Learning. IEEE Access, 11, 103786-103800.

[3] Hussain, S., Gaftandzhieva, S., Maniruzzaman, M., Doneva, R., Muhsin, Z. F. (2021). Regression analysis of student academic performance using deep learning. Education and Information Technologies, 26(3), 783–798.

[4] Ajala, S., Jalajamony, H. M., Nair, M., Marimuthu, P., Fernandez, R. E. (2022). Comparing machine learning and deep learning regression frameworks for accurate prediction of dielectrophoretic force. Scientific Reports, 12(1), 1–18.