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Rainfall Accuracy Prediction Using Deep Convolutional Neural Network and Artificial Neural Network

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ABSTRACT

Rainfall prediction targets the determination of rainfall conditions over a specific location. It is considered vital for the agricultural industry and other industries. A new forecasting method that uses a deep Convolutional Neural Network (CNN) to predict monthly rainfall for a selected location in India. To our knowledge, this is the first time applying a deep CNN in predicting monthly rainfall. In addition, the CNN was compared against a Artificial Neural Networks(ANN). The data for experimental purpose is collected online over the period from 1901 to 2015. The experimental results have suggested a reasonable improvement over traditional methods in predicting rainfall.

Rainfall prediction is challenging in nature due to nature of meteorological data. Precipitation is brought about by a range of meteorological conditions and the scientific model for it is Non-Linear.

Keywords: - Artificial Neural Network(ANN), Convolutional Neural Network(CNN), Forecasting, Precipitation, Non-Linear.

1. INTRODUCTION

Weather forecasting ensures the sustainable development of society and economy. Therefore, the interest in forecasts has started since 650 BC, where Babylonians tried to predict weather based on observations of clouds (observed patterns). Then, multiple philosophers proposed various forecasting theories. Over time, it was noticed that these theories were not adequate. Consequently, it was perceived that there is a need to understand the weather from a broader perspective. With the invention of new instruments, measurement of the atmosphere was undertaken. Various instruments, such as the telegraph and radiosonde, allowed better monitoring of weather conditions. Nowadays, these instruments are used to record weather conditions. For modern rainfall forecasting, forecasts were produced before the invention of the computer. Consequently, scientists introduced new methods that were developed along with the vast spread of technology. Nowadays, scientists use different methods to apply forecasts. Because to its relevance to human life and needs, weather forecasting is applied everywhere in the world.

Rainfall prediction is considered to be one of the important weather forecasting related research since rainfall heavily affects our nature and surroundings. Natural phenomenon such as flood, draught, weather indicators such as relative humidity, etc. are highly affected by rainfall. Thus, robust and accurate methods of predicting rainfall are in interest. Several successful attempts have been made to predict quantitative rainfall.

Rainfall prediction is challenging in nature due to nature of meteorological data. The forecasting is complex as it comprises enormous special fields of data. Precipitation is brought about by a range of meteorological conditions

and the scientific model for it is nonlinear. These days, nonlinear systems exploit neural networks in various studies as they are more suitable for such systems.

2. Literature Survey

This chapter gives the overview of literature survey. This chapter represents some of the relevant work done by the researchers.

An objective method to modify numerical model forecasts with newly given weather data using an artificial neural network

Koizumi K. Weather Forecast., 14, 109–118, 1999

An objective method of forecasting precipitation coverage with a neural network is presented. This method uses as predictors all available data at local weather stations including both numerical model results and weather data obtained later than the model initial time, which sometimes contradict each other and hence have to be handled subjectively by well-experienced forecasters. Since the method gives an objective and also realistic forecast of areal precipitation coverage, its skill scores are better than those of the persistence forecast (after 3 h), the linear regression forecasts, and numerical model precipitation prediction.

Quantitative Rainfall Prediction in Thailand

First International Conference on Hydrology and Water Resources on Asia Pacific Region (APHW), Kyoto, Japan. Manusthiparom C., Oki T., and Kanae, S. , 2003

The rainfall is one of the significant data set of water resource management. With the monthly historical rainfall data in the period of 1941-1999 form 245 rainfall monitor stations in Thailand around Chao Phraya River, the rainfall prediction with an artificial intelligent technique is possible. Artificial neural networks is one the most widely supervised techniques of data mining. It can be applied on predictive mining tasks to make a prediction. The main contribution of this paper is to utilize a neural network model for monthly rainfall prediction. The training and testing patterns are prepared as a time-series data of the past ten months. The numbers of training and testing patterns are 372 and 96, respectively. In the training step, the neural network gives 99.6 % of accuracy and 96.9 % of accuracy in the testing step. The results show that it is possible to predict annual rainfall one year ahead with acceptably accuracy.

Long-range monsoon rainfall prediction of 2005 for the districts and sub-division Kerala with artificial neural network

Guhathakurta, P, Current Science 90:773-779, 2006

The advantages of artificial neural network technique for explaining the nonlinear behavior between the inputs and output is explored to forecast the monsoon rainfall of 36 meteorological sub-divisions of India. The model uses the past years of monsoon rainfall data only to forecast the monsoon rainfall of coming year. Monthly rainfall time series data for each of the 36 meteorological sub-divisions constructed by Guhathakurta and Rajeevan (2007) is used for the present study. The model captures well the input-output nonlinear relations and predicted the seasonal rainfall quite accurately during the independent period. All India monsoon rainfall forecasts were generated by using area weighted rainfall forecasts of all the sub-divisions. For the first time the idea of up-scaling is introduced in

monsoon rainfall prediction using neural network technique and it is shown that up scaling helps to capture the variability of the all India rainfall better. This helps to predict the extreme years like 2002, 2004 better than the neural network model developed based on single time series of all India rainfall. However, derivation of smaller scale (sub-divisions) forecast model may be more useful than the all India forecast.

Modeling inter-annual variation of a local rainfall data using a fuzzy logic technique

Halide, H. and Ridd P., Proceedings of International Forum on Climate Prediction, 2002, James Cook Universiy, Australia, pp: 166-170, 2002

The present study investigates the ability of fuzzy rules/logic in modeling rainfall for South Western Nigeria. The developed Fuzzy Logic model is made up of two functional components; the knowledge base and the fuzzy reasoning or decision making unit. Two operations were performed on the Fuzzy Logic model; the fuzzification operation and defuzzification operation. The model predicted outputs were compared with the actual rainfall data. Simulation results reveal that predicted results are in good agreement with measured data. Prediction Error, Root Mean Square Error (RMSE), Mean Absolute Error (MAE) and the Prediction Accuracy were calculated, and on the basis of the results obtained, it can be suggested that fuzzy methodology is efficiently capable of handling scattered data. The developed fuzzy rule-based model shows flexibility and ability in modeling an ill-defined relationship between input and output variables.

3. Objectives of System

- The objective of this project is to help Science and Automations to trace the patterns that make sure the rainfall in proportions was accurate.
- The usual process to trace the rainfall is using physical tools which requires time and could come up with certain errors.
- The CNN and ANN make sure that the rainfall data provided is utmost and validable to the point of going for further pre operations related to weather data machinaries.

4. Problem Statement

Rainfall prediction can broadly be classified into two categories.

One is by analyzing the different physical laws that governs rainfall in a particular region.

Though, the approach sound fair enough, it has been found that the number of such constraints that governs rainfall is both spatial and temporal. Thus, the prediction involves too much mathematical calculations and hence is not computationally feasible.

The second approach involves expert systems to be involved and discovering hidden patterns of how different features that affects rainfall are actually related with physical rainfall.

The later approach has been found to be more suitable. The modern advancement in research of Neural Networks has proved that the expert systems based on NNs are exceptionally accurate and robust in solving real life problems. Achieving expected accuracy is challenging.

5. Implementation Details of Module

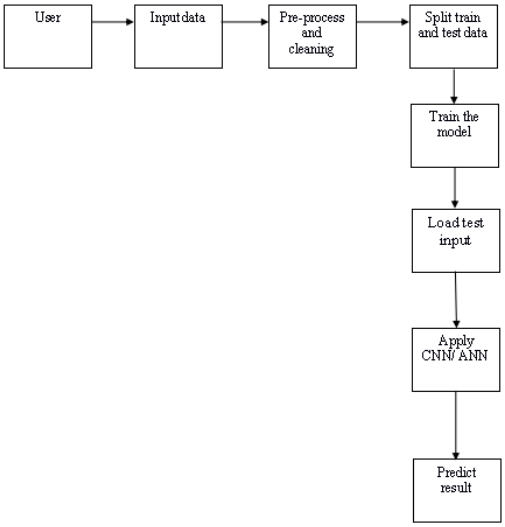

Fig: - System Architecture

6. CONCLUSION

A neural network based approach has been proposed to forecast monthly rainfall for all states in India. A deep CNN was developed to predict monthly rainfall. This study highlighted the ability of CNN in performing in a rainfall prediction task. In addition, the capability of convolutional neural networks in performing in a monthly rainfall prediction has been evaluated. The study showed that the CNN was performing better in months with high annual averages compared to alternative approaches.

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