

# Cognitive Computational Approaches for Weather Forecasting: An Overview and Progress

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**Abstract:** From the beginning human always willing to predict the things accurately so that he can be ready for the consequences of things in advance. Prediction of weather is one of the few tasks that drastically affect human life. Weather forecasting is an effort to find out the expected weather conditions in advance (Kothapalli, 2018). In this paper, A Real-time weather forecasting and analysis has been done using the parameters temperature and humidity. Here correlation analysis is used as a key for prediction in an ARIMA (Auto-Regressive Integrated Moving Average) Model. In the past, we have seen old physical prediction models that were not much appropriate for the forecast due to the random nature of weather over a long period. In the current scenario, we see Techniques like Machine learning, IoT, ANN are more robust in prediction with more accurately and for a longer period. But these things are limited to machines, we want to make a more advancement by making machine think like a human So that natural intelligence of human can govern over the machine and we go for prediction in a much realistic way. We can determine new class of problems using Cognitive computing (CC). it deals with complex problems same way as human tackle the unknown problems (Sarma, 2016). The purpose of this paper is to analyze weather forecasting using different computing techniques and design a more efficient prediction model using cognitive computing.

## 1 INTRODUCTION

The weather forecasting is a task in which human indulge themselves from the beginning either scientifically or verbally but accurate weather prediction always being a challenging task for them due to the variable nature of weather affecting parameters that change very frequently, it may include wind speed, sea surface temperature, atmospheric pressure, etc.

In the past when people don't have the luxury of today's modern technology they were used to predict the weather using relative phenomena like if its cloudy" it will rain" or may be its already raining nearby. They simply try to understand the behavior of nature from things like wind, sky, moon, clouds, aroma of air etc. (Refonaa, 2018) In this paper, the author stated that cognitive computing techniques give better results compared to statistical techniques. The ever-changing nature of the atmosphere expects a high and refined computation to arrive at accurate

results. It turns out to be an indispensable activity nowadays as most sectors including agriculture, industries, aviation, etc. are getting highly reliant upon it. (Goswami, 2014). In this paper, the author used a REGCM (Regional Climate Model) open-source Model for predicting the weather parameters as a dynamic prediction.

We can say that Cognitive computing techniques can be used to generate solutions for "vague, ambiguous, qualitative, incomplete, or imprecise information. This technique also yields a lower percentage of error in prediction rate. And also it is more appropriate for subjective and qualitative data.

Cognitive computing studies the development of self-study programs that naturally interact with people in complex and adaptable contexts and changes in language and meaning. These programs mimic the processes of the human mind, define a large number of details, discover complexity, test ideas, make predictions and clues, come to conclusions, and so on. This is a field of emerging

multidisciplinary research, the backbone of artificial intelligence, integrating and entertaining scientific results from a variety of fields, such as natural language analysis, information representation and consultation, audio and video analysis, neuroscience, computer-human communication.

## 2 COGNITIVE COMPUTATIONAL APPROACHES

In Cognitive computing we try to mimic the human way of thinking for finding the solutions of complex ambiguous scenarios. When we are not certain about the events, then we try to solve things by our own vision. This thing we can see in IBM's cognitive computer system, known as Watson. In this Technique we see lower chances of prediction error and produces a better qualitative and subjective data.

### 2.1 Theory of Cognitive Computing

This paper describes how can we process information after learning. We can say that learner has to become an active member in the process. Learner has to use his skills, wisdom, consciousness, clues that they have accomplished prior. It is necessary that learner build his forgiving while going through different situations on behalf of his prior experience and intelligence.

### 2.2 Learner-centered Approach

Learning is a process that depends upon the capacity of individuals, when we read anything then we relate this with our existing knowledge data base and try to figure out the outcome based upon the reasoning.

We can see this cognitive learning approach while teaching students. Here location, information and Balance are key parameters for learning

- Housing - We see the transformation from what we already know to what we are looking for new.

Information – how new details are arranged in our heads next to what we already know.

- Balance – here we see the balance between what we already know and what we are learning now

According to Piaget, learning is an association between the information we already know with new information. For this we have to create a safe learning environment. It is a place where inquiring mind is supported and forbearing is accepted. It is

very important to know how to plan a course or stream for learning and growth.

- We have to create a fresh insertion of record on the existing information
- Study stuff should be branched into correct parts and should follow a sequence.
- Thoughts of interns should be taken seriously and their suggestions should be implemented.

### 2.3 Data Mining Technique

Prediction of weather can be taken by many Data Mining techniques, Clustering, Decision Trees and Neural Networks are few of them.

This method is based on the hidden patterns and relations among them and validate our results by verification on the input parameters.

Data Mining includes following stages -

1. Assemblage of Data
2. Purification of Data
3. Selection of Data
4. Conversion of Data
5. Tapping of Data

### 2.4 Fuzzy Logic Technique

Fuzzy logic deals with the sectional truth where truth vale may differ from completely false to completely truth. We can say Fuzzy logic find the degree of truth. It is resemblance to human reasoning. It is applicable when values are between absolute true and false. Here we see a membership function that tells how a variable relates with a Set to the interval  $[0,1]$

### 2.5 Genetic Algorithm Technique

It is a heuristic Search Technique and is based on Darwin's theory of evolution. It is a searching process in which most powerful individual are selected and fittest individual get chance of reproduction to generate the candidate for upcoming generation. We can see a famous way to train Neural Networks is hybrid backpropagation using genetic algorithm. The shortcoming of this method is that we assume that weather parameters are not correlated with each other, so we can't get the benefit of correlation analysis. To eliminate this few authors proposed a modified time series based weather prediction.

## 2.6 Deep Learning Technique

Mostly people are confused among Artificial Intelligence, Machine learning and Deep learning. In Artificial Intelligence we try to simulate human intelligence in machines, that includes all human way of thinking and working. Machine learning can be considered as a subset of Artificial Intelligence that can be used for prediction without explicitly programmed. It uses past data for prediction. Machine learning is not much useful when we go for fields like natural language processing or image processing that includes a large number of parameters needed for prediction.

Deep Learning is a subset of Machine Learning Where we see multiple hidden layers. Deep Learning can deal with multiple predictors while prediction. Deep Learning can generate new prediction predictors besides the input parameters. It is effective when we have large amount data to deal with.

Deep learning is a subset of machine learning in artificial intelligence that has networks capable of learning unsupervised from data that is unstructured or unlabeled. Also known as deep neural learning or deep neural network. The objective of our investigations is to explore the potential of deep learning techniques for weather forecasting using rich hierarchical weather representations which are learned from massive weather time series data.

## 3 RELATED WORK

We have seen so many weather prediction models in the past and also see comparative study among the models for analyzing the performance. (Saima, 2011) In this paper, the author has done a review on intelligent methods for weather forecasting and concludes that no existing model is perfect by which we can predict the weather conditions accurately.

In paper (Echevarría, 2011) Author has described rainfall prediction through deep learning. Here Prediction of next day has been done on the basis of previous day data. The data used for prediction contains 47 parameters containing temperature, humidity, wind speed etc. We see author has used a deep learning based forecasting model. Author claims better result on behalf of MSE and RMSE. Heavy Rain conditions are used for testing and forecasting of light rain is considered as a future work. Deep Belief Network based on Restricted Boltz-Mann Machines setup has been used by analyzing neighboring geographic proximity and altitude.

In paper (Miyoshi, 2016) Author has shown how Big Data Assimilation with next generation sensors and high end computing can improve the numerical weather prediction. As BDA updates the system every 30 seconds and with 100-m resolution it can do precise prediction. In paper (Jain, 2017) Author has presented how time series data is key component in prediction of weather.

In paper (Ghosh, 2016)) topic of Fuzzy Logic as a decision making technique has been introduced. It was suggested that applications of this technique could be effectively applied in the area of operational meteorology. An instance of such an application, the forecast of the probability of temperature, was discussed and examples of the method were presented.

In paper (Vaščák, 2015) Author presented a compact weather prediction system basically for industry need that can be used for other fields, mainly in weather research, transport and firewall system etc. In paper (Navadia, 2017) Author used Hadoop based prediction analysis of weather. Proposed system takes large rainfall data as input and went for prediction on behalf of day, quantity etc. to predict accurately. Predictable types of analysis hold relationship between multiple items in a risk assessment data set with specific set of criteria for allocation of points on weight. In paper (Babu, 2017) Author prepared a Wi-Fi based set up for prediction. It is tried to cut the cost using light part in terms of cost. In paper (Chen, 2018) Author has discussed Cognitive Computing while aiming on three terms, i.e., IoT, big data and cloud computing.

In paper (Abrahamsen, 2018) Author predicted the temperature using ANN and mainly describe Python API for data collection. It was explained that how this data can be used in Machine Learning. In paper ( Mohammadi, 2015) Author did a survey on features of IoT Data and difficulty for Deep Learning Method. We saw several Deep Learning model based on two main features-IoT Big Data and IoT Fast Streaming data. In paper (Kunjumon,2018) Author mentioned different data mining algorithms for the prediction of weather and concluded that Support Vector Machines can give better result with almost 90% accuracy. In paper (Huang, 2019) Author describe show in recent years, computer technology for understanding has grown with maturity, and programs such as in-depth learning has provide great performance. It is about designing and implementing a comprehension model that focuses on the similarity of sentence questionnaires for individual Institutions. In paper (Scher, 2019) Author presented the broadcasting model for

training the Deep Neural Networks. This Model produces few days ahead forecasting results. Author also give thought about how neural network model is dependent on the timing of training period and concluded that a seasonal cycle is more effective compare to the model that having outside of the season cycle.

In paper (Zantalis, 2019) Author Described how things vary with the growth of the Internet of Things (IoT), apps have become more sophisticated and connected devices are starting to exploit all aspects of the modern city. We see if we use large set of data collection, Machine Learning (ML) techniques are used to further ingenuity and strength of the application. The field of intelligent transport has impressed many researchers and has influenced both the ML and the IoT. In this case, smart transport is considered to be an umbrella term that includes route design, parking, traffic lights, prevention/detection, road maintenance, and the use of infrastructure. Here Author mainly focuses on Machine Learning Algorithms and IoT System for Intelligent transportation system. In paper (Samsonovich, 2020) Author used eBICA based structure to simulate emotional and social intelligence of human. A brief review was done on making a virtual assistant that will act as a partner of human in day to day life.

In paper (Krishnaveni, 2020) Author tried to predict weather using Big Data Analytics. SPRINT Algorithm has been used for prediction on WEKA climate Data. Decision tree based approach has been used for constructing the tree model. In paper (Holmstrom, 2016) Author presented the application of Machine Learning for a large period of prediction, that gives better results over a shorter period of time. In paper (Bhardwaj, 2019) Author did temperature prediction and found that Support Vector Machine gave best result for this compare to other approaches. He also concluded that for the rainfall prediction best model was Multi-Layer perceptron. In paper (Janani, 2014) Author Nearly compared about 10 papers with their problem, and conclude that Fuzzy Logic and ANN provide better result compare to others. In paper (Navadia, 2017) Author did rainfall prediction using HADOOP and predict min, max and average rainfall in effective way. In paper (Omary, 2012) Author used Data Mining Techniques and Artificial Intelligence for upcoming precipitation based on past data. As climate changes very often, Static approaches and Data Mining was used for better results.

In paper (Vamsi, 2015) Author used ARIMA Model for weather forecasting that has the quality of

doing appropriate analysis of weather forecasting. In paper (Reddy, 2017) Author mainly discussed the various weather predictions models proposed by different researchers. In paper (Gurung, 2017) A survey has been done on weather forecasting using different ANN Architecture of 20 to 30 years. In paper (Culclasure, 2013) Author discovered the recent implication of ANN on weather prediction over a custom Data. In paper (Priya, 2015) Author told the benefits of Big Data Analytic for weather prediction. In paper (Kapoor, 2013) Author used a Sliding Window concept for prediction and this gave best result except the months where changes take place very frequently.

In paper (Kumar, 2013) Author effectively predict maximum and minimum temperature using ANN and simulation is done using MATLAB. In paper (Olaiya, 2012) Author forecasted maximum temperature, rainfall evaporation and wind speed using ANN and Decision Tree for the city of Nigeria. In paper (Karunakara, 2019) Author did weather forecasting on large satellite data and propose Cumulative Distribution Function (CDA) for analyzing the complicated weather prediction. This gives better result in varying climate. In paper (Muqem, 2016) Author did a Survey on different data mining techniques and review these in tabular format. In paper (Samya, 2016) The main purpose was to explore various cloudburst forecasting strategies using Data Mining and Artificial Neural Network (ANN), in the literature. The most widely used parameters for analyzing cloudburst forecasts: temperature, rainfall, evaporation, and wind speed. From research, know that prediction using big data analytics is the best solution for obtaining accurate cloudburst predictions.

In paper (Yonekura, 2019) Author did a short term prediction on data provided by the network of private companies. Different Sensors has been used for collecting the data. In paper (Sheikh, 2016) discussion was done on various strategies and algorithms that can be selected to predict the weather and sheds much light on effective prediction. Various other integration techniques are used to maximize application performance. Findings: After comparing algorithms and the respective integration process used to maximize performance, a distinction is attained that will further predict the weather.

In paper (Madan, 2018) Authors have a practice of checking the continuous decline of the mathematical line and supporting vector machine learning strategies that statistical team details of the groups are consistent and symbolize weather forecasts or forecasts. Under the proposed system

we tend to focus on the unpopular algorithmic law that provides close and imminent weather forecasting results for the next 5 days and finally, the results are calculated from the mathematical decision-making tree view and the terms and conditions vide confusion matrix for accurate and accurate prediction using Big Data. In paper (Taib, 2015) two data mining techniques Classification and Clustering has been discussed on time series data. These can be prepared using feature based and instance based. In paper (Kalaiyarasi, 2013) prediction was done on most common parameters like rainfall, wind speed, temperature, and cold etc. using various Data Mining Techniques.

In paper (Lee, 2020) Author used 3 kind of neural networks, multiple layer perceptron, repetitive, and convolutional, in predicting daily measurement, magnitude, and magnitude having input parameters that are higher in frequency than the investigators used in past. To incorporate this neural network into visual data from three locations with different weather features, the authors present that predicting result with standard input data is better than predicting the result of non-standard daily input. In paper (Hewage, 2020) Authors proposed a low-cost unpredictable weather forecasting model by examining short-term memory modeling methods (LSTM) and temporal convolutional (TCN) networks and comparing their result with recent machine learning methods, mathematical prediction methods, and a powerful integration method, and a well-established climate study and forecast (WRF) NWP model. In paper (Haupt, 2018) Author discussed about many emerging weather forecasting applications that best combines our knowledge of physics, numbers, and non-personal intelligence using smart Big Data and using the Internet of Things. In paper (Jain, 2020) Author suggested a method of crop selection to increase crop yields depending on climatic and soil parameters. It also shows the right time to plant the right plants used to predict the weather of the year. Mechanical learning algorithms such as the Recurrent Neural Network is used to forecast the weather, and the random forest planning algorithm is used to select the appropriate plants. The result of the proposed weather forecasting method is compared to standard installation networks, which show better performance results for each selected weather parameter.

In paper (Lee, 2004) Authors suggested a smart, intelligent environment based on multiple elements, namely the intelligent Java Agent Development Environment (jade), to provide an integrated and

intelligent platform-based e-commerce platform.

In paper (Wibisono, 2018) weather prediction was made using a new Artificial Intelligence technique called the Knowledge Growing System. The Knowledge Growing System uses weather forecasting methods as the behalf for weather forecasts. The result shows that decision-making is necessary when considering OM-A3S predictions and learning from A3S to obtain good predictive results.

In paper (Tajane, 2018) Author discussed how a chat-bot can be helpful in giving good results in a variety of situations. This uses features of life - saving messages as Google (Google Assistant), Amazon (Alexa), Microsoft (Cortana), and Oracle use a lot of energy and money to research their clients. In paper (Muthurasu, 2018) Author provided an idea of how you can get more information from accurate agricultural data using a large data method. Large data sets on agricultural systems provide new insights into advancing advanced climate decisions, improving productivity, and avoiding unnecessary costs associated with harvesting, pesticide use, and fertilizer.

In paper (Shivaranjani, 2016) Author did a Survey on various Data Mining approaches that he used for prediction. The aim was to help farmers by doing precise weather forecasting so that they nourish the soil and go for worthy production. Author used Techniques like ANN, Fuzzy Inference Systems, Decision Tree Methods to achieve this.

#### 4 RECOMMENDATION AND OBSERVATION

It is observed that traditional methods are not sufficient for effective weather prediction as they have certain limitations or we can say that is purely based upon the previous data and finding the patterns based on the given data, nowadays we need a more advance way of prediction that not only use the computation ability of a machine but also use analysis power of human. So Cognitive Computing will be an effective solution to handle weather conditions that change very frequently. So it is recommended that we build a system that has thinking capabilities like a human and work efficiently like a machine.

## 5 CONCLUSIONS

From the above review, It can be concluded that for accurate prediction of weather we can't fully rely on a statistical method of prediction .if we have to increase the accuracy then we have to use our cognitive computing methods because these cognitive methods not only find the result for provided predictors but these are also able to self-generate new predictors that will help us in predicting complex fields where we see a large number of attributes i.e. Image Processing, Natural Language Processing Weather Forecasting, etc.

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