Mutual city/state weather forecasting by ANN and HMM – Survey

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Abstract— Weather forecasting is an important apply for in meteorology and has been one of the most scientifically and technologically difficult problems around the world. Weather prediction approaches are challenged by difficult weather phenomena with incomplete explanation and past data. Weather phenomena have many parameters that are impossible to enumerate and measure. Increasing development on statement systems enabled weather forecast expert systems to combine and divide resources and thus hybrid system has emerged. Even though these improvements on weather forecast, these expert systems can't be fully reliable since weather forecast is main problem. A predictive Neural Network model and Hidden Markov Model was also residential for the weather prediction program and the outcome compared with real weather data for the predicted periods. The results show that given enough case data, Data Mining techniques can be used for weather forecasting and climate change studies. Data mining is a process that uses a variety of data analysis tools to find out patterns and relationships in data that may be used to create applicable prediction. The proposed ANN and HMM evaluates the presentation of the developed models by applying unusual neurons, hidden layers and transfer functions to predict temperature for 365 days of the year. The criteria used for suitable model selection is mean square error (MSE).

Keywords— ANN, HMM, weather predication, regression, training, testing, Numerical Weather Forecasting etc.

I.   INTRODUCTION

Weather forecasting is the prediction of what the environment will be like in a particular place by using technology and technical knowledge to create weather observations. In other words, it's a method of predicting things like cloud cover, rain, snow, wind speed and temperature before they happen. Weather forecasters use all kinds of tools to get this goals. A hidden Markov model (HMM) is a statistical Markov model in which the system being modelled is assumed to be a Markov process with (unobserved) hidden states. An HMM can be presented as the simplest dynamic Bayesian network. Hidden Markov models are especially known for their application in temporal pattern recognition such as weather forecasting, speech, handwriting, Gesture recognition, etc. The HMMs can be used for generating alignments, with each state of the machine related to one column in the alignment. The HMM wants to be trained on a set of seed sequences and generally require a larger seed than the simple Markov models.[3]

Hybrid Markov Model is specifically used for sequence and observation describe that they are used to find the possibliabilty and that to in proper sequence there are many algorithms used in HMM they as follows Viterbi Algorithm, Backward algorithm or Forward algorithm, Posterior decoding, done by a combination of the backward and forward algorithm, Baum-Welch algorithm.[6]
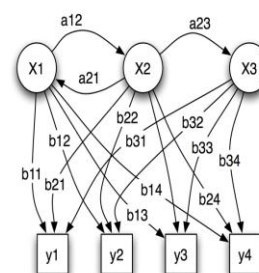

Figure 1.   Probabilistic parameters of a hidden Markov model

X — states
y — possible observations
a — state transition probabilities
b — output probabilities

Artificial neural network is inspired by biological neuron model. In artificial neural network numbers of highly nonlinear neurons are interconnected so as to forming a network. The neural network consists of three layers; these are   input, hidden and output layers. These neurons are connected by links which comprises of weight; weights are the connection quality which exists between the neurons in the system.[1]
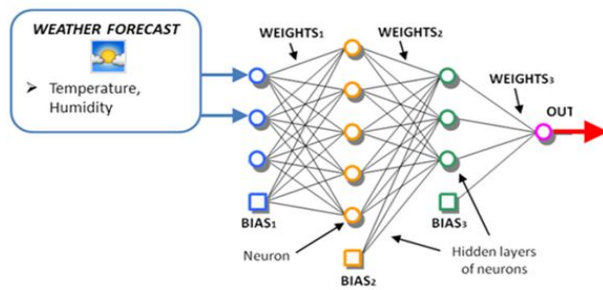
Figure 2. ANN Diagram

Section I contains the introduction of basic approach for weather forecasting. II contain the related works of basic literature papers. Section III contain the methodology and algorithms section IV explain the comparative study between different algorithms, Section V describes proposed system flow and its description and at last conclusion and future scope.

II. RELATED WORK

Dires Negash Fente, Prof. Dheeraj Kumar Sing, Weather Forecasting Using Artificial Neural Network (2018), in this research work, a proposed model for weather forecasting system is implemented using recurrent neural network with LSTM technique. In this model the data is trained using LSTM algorithm. From experimental result, it is observed that Long-Short Term Memory neural network gives substantial results with high accuracy among the other weather forecasting techniques. The proposed model for weather forecasting using recurrent neural network with LSTM algorithm essentially intends to gather data that is weather parameters, like temperature, humidity, pressure, dew point, wind speed, precipitation and visibility. These predictors are taken as input neuron to recurrent neural network. Weather forecast is made by gathering weather information in regards to the past and current status of the weather and utilizing this information to train LSTM model. [1]

Lydia Bouzar-Benlabiod, Stuart H. Rubi, Lila Meziani, Randomization-Based Knowledge Discovery with Application to Weather Prediction (2018), a new approach to weather prediction using CBR. The observations are taken from a dataset and are considered as valid knowledge. We associate to each observation another observation recorded two days later. This constitutes a case. The case base is segmented according to calendar months. A Randomization step is performed to complete unknown information. Then, another randomization is performed either to generalize the existing cases (and this will reduce the case base size), or to generate new knowledge. The new knowledge has a high probability to be valid, since the generated case attribute values fall between two valid attribute values– all other values being equal. Of course, a case's distance threshold, under which a randomization is triggered, is fixed. The results show

that by completing missing values and randomizing, more results are returned by the CBR system and the case base is smaller than the initial one due to generalization. The resulting case base is richer than the first one due to the generated new knowledge; and, it is more concise due to knowledge generalization. [2]

Diksha Khiatani, DR. Udayan Ghose, Weather Forecasting Using Hidden Markov Model (2017) Hidden Markov Model in various application but it was the first time that is has been used to predict weather pattern. It would be great if this approach could be implemented in various field and thus these field could benefit from this. The output obtained shows the weather pattern only predict temperature and also exact temperature is not obtained. Many efforts has been made to use Hidden Markov Model in various application but it was the first time that is has been used to predict weather pattern. The result expected and the results so obtained were quite similar and show that our approach works well in predicting the next five. It would be great if this approach could be implemented in various field and thus these field could benefit from this. [3]

Ravina Chauhan, Sheetal Thakkar, Neural network based weather forecasting mode (2017) aim in this dissertation is to propose model based on Neural Network and their variations. So as effectively predict future values considering past multi-attributes data. Entire Weather prediction relies on correct collection of meteorological data, and appropriate selection of data mining techniques. More than one data mining technique is however applied in parallel for better and accurate results. Artificial Neural Networks can detect the relationships between the input variables and generate outputs based on the observed patterns inherent in the data without any need for programming or developing complex equations to model these relationships. So as effectively predict future values considering past multi-attributes data. Model. We have present weather yearly forecasting using Hidden Markov Model and ANN.As in ANN number of hidden layer increases accuracy will increases. And by adding parameter Humidity with temperature accuracy and performance of network also increases. [4]

Himani Tyagi ,Shweta Suran, Vishwajeet Pattanaik Weather - Temperature Pattern Prediction and Anomaly Identification using Artificial Neural Network(2016) Analogue Method, Atmospheric Model, Artificial Neural Network, Data Modelling, Numerical Weather Forecasting, Interpolation, Primitive Equations, Spline, Statistical Probability, Steady-State/Trend Method. On the basis of discussed experimental results, it is concluded that the proposed system is able to resolve some of the issues discussed earlier. The performance of the proposed system is equivalent, if not better than other systems currently being used. The performance of the system is defined in terms of data modelling, handling missing data, execution time and mean square error for test data. The proposed methodology currently functions only on Temperature data; although the same method can be used to predict weather prediction parameters like: Relative

Humidity, Barometric Pressure, Wind Speed & Direction, etc. [5]

Lili Long, Hongbin Dong, Vue Pan, Li Huangfu, Naikang Gou, Xingmei Wang, Forecasting Model for Bidding Behavior of Advertisers Based on HMM (2015) they have studied the characteristics of advertisers' request behaviour by establish HMM forecasting model, they model advertisers' bidding behaviour through their historical data to reproduce the change of advertisers' bidding sequence. The data mining procedure based on association rule mining for extracting relationships among climate parameters over Cuddlier station was applied to extract the intense summer day (hot day) patterns during summer months. The proposed data mining methodology is more useful to apply with threshold values. As evidenced in the results, the methodology is suitable for monitoring and predicting the temperature days 48 hours ahead. This method promises to be a useful one for tropical coastal stations. By anticipating the extreme summer temperature, the day to day practice will also be planned in advance based on human comfort. [6]

Marzieh Razavi1, Ramya Rasipuram, Mathew Magimai.-Doss, on modelling context-dependent clustered states: comparing HMM/GMM, hybrid HMM/ANN and KL-HMM approaches (2014) Deep architectures have recently been explored in hybrid hidden Markov model/artificial neural network (HMM/ANN) framework where the ANN outputs are usually the clustered states of context dependent phones derived from the best performing HMM/Gaussian mixture model (GMM) system. We can view a hybrid HMM/ANN system as a special case of recently proposed Kullback-Leibler divergence based hidden Markov model (KL-HMM) approach. In KLHMM approach a probabilistic relationship between the ANN outputs and the context-dependent HMM states is modelled. In this paper, we show that in KL-HMM framework we may not require as many clustered states as the best HMM/GMM system in the ANN output layer. Our experimental results on German part of Medieval database show that KL-HMM system achieves better performance compared to hybrid HMM/ANN and HMM/GMM systems with much fewer number of clustered states than is required for HMM/GMM system. The reduction in number of clustered states has broader implications on model complexity and data sparsity issues. [7]

Andrew Culclasure Georgia Southern University. Using Neural Networks to Provide Local Weather Forecast (2013) artificial neural networks (ANNs) have been applied extensively to both regress and classify weather phenomena. While one of the core strengths of neural networks is rendering accurate predictions with noisy datasets, there is currently not a significant amount of research focusing on whether ANNs are capable of producing accurate forecasts of relevant weather variables from small-scale, imperfect datasets. Also, there is not a significant amount of research focusing on the forecasting performance of neural networks applied to weather datasets that have been temporally rolled-up from a base dataset. In this paper, a survey of existing research on applying ANNs to weather prediction is presented. Also, an experiment in which neural networks are used to regress and classify minimum temperature and maximum gust weather variables is presented. This experiment used a dataset containing weather variables recorded every 15 minutes over the course of a year by a personal weather collection station in Statesboro, Georgia. [8]
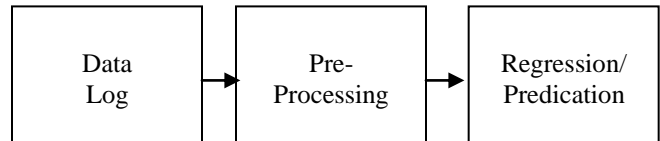
III. METHODOLOGY

Figure 3.   Basic Steps

A. Data Log:

The dataset of data logging is the process of collecting and storing data over a period of time in order to analyze specific trends or record the data-based events/actions of a system, network or IT environment. It enables the tracking of all interactions through which data, files or applications are stored, accessed or modified on a storage device or application. Stored, accessed or modified on a storage device or application. Data logging enables the recording of activity performed on one or more data/file objects or sets. Typically data logging records events/actions, such as the data's size, most recent modification and username/name of the individual that modified the data. Data logging also facilitates the storage and collection of computer or device information. For example, data logging can store processor temperature and memory utilization over time and network bandwidth usage. System/network administrators use this data to analyze system or network performance during a specific period.[2]

B. Pre-processing:

The "discovery of leukemia via microscopic image starts with the image acquisition level. At this step, the blood sample's microscopic image are captured through the digital camera to induce image inside as the digital data. The sunshine experience determines the quality of microscope image inside the method of" observing the cell through a microscope. Therefore, image pre-processing enables the choice method to vary the image to be plenty of merely tackled by humans or machine [1].

C. Regression:

Regression analysis is widely used for prediction and forecasting where its use has substantial overlap with the field of machine learning. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer casual relationships between the independent and dependent variables. However this can lead to illusions or false relationships, so caution is advisable.[7]

ANN:
An artificial neural network is composed artificial neurons that are linked together according to a specific network architecture. The objective of the neural network is to transform the inputs into meaningful outputs.An artificial neural network (ANN), usually called neural network (NN), and is a mathematical by the structure and/or functional aspects of biological neural networks. Ann is used pattern recognition, interpretation, prediction, diagnosis. [1]

Hybrid Markov Model:
An simpler Markov models (like a Markov chain), the state is directly visible to the observer, and therefore the state transition probabilities are the only parameters, while in the hidden Markov model, the state is not directly visible, but the output (in the form of data or "token" in the following), dependent on the state, is visible. Each state has a probability distribution over the possible output tokens. Therefore, the sequence of tokens generated by an HMM gives some information about the sequence of states; this is also known as pattern theory, a topic of grammar induction. The adjective hidden refers to the state sequence through which the model passes, not to the parameters of the model; the model is still referred to as a hidden Markov model even if these parameters are known exactly.[6]

IV.   COMPARATIVE STUDY

Table I. Comparison between Classification Method

Method	Application	Advantages	Disadvantages
Neural Network	Robotics Medical diagnostic. Email Spam filtering. Speech recognition.	Ann can perform tasks which linear program cannot. When element of neural network fails it continue to work.	They do not classify and cluster data. Need a lot of chips and a distributed run-time to train on very large datasets.
Hidden Markov Model	Recognition Observation Symbols System State Identification Parameter Initialization	The HMMs can be used for generating alignments, with each state of the machine related to one column in the alignment.	The HMM wants to be trained on a set of seed sequences and generally require a larger seed than the simple Markov models.

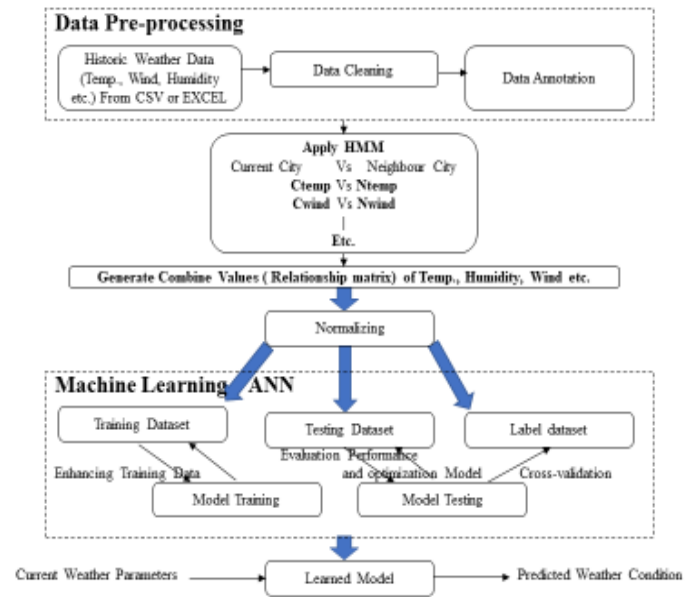## V.   PROPOSED WORK

Figure 4.   Proposed Flow

The proposed work is followed by the following steps that are performed here:

1. Data pre-processing: In this step, historic weather data like temperature, humidity, wind, and etc. data are been collected. Then, data cleaning method is being proceed due to which the unsupervised data and supervised data is being clean. Then, data automation process is proceed.

2. HMM: by applying HMM algorithm current city weather and neighbour city weather will be predicated for example: C (temperature) vs N(temperature) C (wind) vs N (wind) and so on.

3. Generation of combination relationship matrix of temperature, wind, humidity, etc.

4. Normalizing of data: Database Normalization is a technique of organizing the data in the database. Normalization is a systematic approach of decomposing tables to eliminate data redundancy (repetition) and undesirable characteristics like Insertion, Update and Deletion Anomalies. It is a multi-step process that puts data into tabular form, removing duplicated data from the relation tables.

5. Machine learning ANN: testing of data, training of dataset, label dataset

6. Learned model: current weather predication to predicated weather condition.

VI.   CONCLUSION

After Studding different methods for weather forecasting all system work with single humidity, temperature, snow,

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rainfall, windy, etc. parameters. As in ANN number of hidden layer increases accuracy will increases. And by adding parameter Humidity with temperature accuracy and performance of network also increases. But if we take the data of two countries / cities together and give the actual data on humidity, temperature, snow, rainfall, windy, etc. parameters will be compare every day, hour, week, month, time to time will be calculated and also with the help of ANN will show the comparison of two countries/ cities (mutual) for next five years data. To propose model based on Neural Network and their variations. So as effectively predict future values considering past multi-attributes data.

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