International Journal of Recent Development in Engineering and Technology
Website: www.ijrdet.com (ISSN 2347-6435(Online) Volume 10, Issue 7, July 2021)

Weather Forecasting Using Neural Networks and Visualization Using MATLAB

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***Abstract*— The utilization of science and innovation to anticipate climate conditions is known as weather forecasting. The agricultural and industrial sectors both benefit from it. Weather forecasting in a complex atmosphere can benefit from artificial neural network models that use a supervised learning methodology. The model requires a training process to provide weight and bias values. This study presented a weather forecasting approach based on Fireworks Algorithm-trained Artificial Neural Networks. The Fireworks Algorithm is a Swarm Intelligence Algorithm for advancement that was simply evolved. The method's main goal is to forecast daily mean temperature using numerous observed characteristics obtained from Bangkok's Meteorological Station. The results of the experiments show that the proposed strategy is useful for weather forecasting.**

***Keywords*— Neural network, back propagation, forward propagation, Levenberg-Marquardt Algorithm, MATLAB.**

I. INTRODUCTION

1.1 Conventional Weather Forecasting

The most common technique that is used in the weather forecasting is the persistence form of approach that depends on the conditions of the present to predict the climate of the future. This is considerably a very effective form of prediction where the weather is steady, for example the summers observed in the tropical regions. This format of predictions is based largely on the stationary, stable and unchanging weather patterns. Though this method has its advantages over the shorter range of predictions, but this method is not applicable for longer range of forecasting. Besides the pressure tendencies that are studied, the condition of the sky also plays an important part in the forecasting of the weather in mountainous regions. The change in the density of the cloud cover, the foray of clouds or the change or the deepening in the color of the cloud are few of the observed indications for rain in the future. For many years, the sky cover has acted as a decoy for weather forecasting.

However, this is definitely not a solid methodology and is only a theory made by noticing the sky.

1.2 Radical Weather Forecasting

Weather or Climate Map is an interaction of investigation of satellite, radar symbolisms and other information. The climate graph portrays the appropriation examples of pneumatic force, wind, temperature and stickiness at various levels of the air. There are two kinds of the fundamental climate outline in particular, the surface guide and hence the upper-air maps. There are five normal stages in the upper-air maps that are made double a day with twelve hours recess. The surface guides are made fourfold every day at six-hourly spans. On a superficial level guides, the conveyance examples of downpour or different kinds of precipitation and darkness likewise can be depicted. Exceptionally modern and dear innovation is utilized. Climate changes ought to be seen each hour. The extraction of hidden predictive information from massive databases is known as data mining. It's a strong new technology that has a lot of promise for helping firms focus on the most important data in their data warehouses. Data mining software forecasts future trends andbehaviors, allowing firms to make informed, proactive decisions. Data mining's automated, future analyses go beyond the analysis of previous occurrences provided by decision support systems' retrospective capabilities. Pattern extraction from data has been done by hand for generations.

II. PROPOSED METHOD

2.1 Dataset Used

The data is collected from the https://data.world/datasets/weather. The dataset contains data about the temperature, humidity, rainfall, dewpoint, pressure, visibility, wind speed. The data is from 1997 through 2014. This dataset is used for the prediction of the annual day-to-day weather forecasting of the year 2015.

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2.2 Algorithm Used

2.2.1 Back Propagation

Back propagation is a popular approach for training feed forward neural networks in machine learning. Back propagation has generalisations for various artificial neural networks and functions in general. Back propagation, as opposed to a guileless direct calculation of the angle concerning each weight independently, registers the slope of the misfortune work as for the loads of the organization for a solitary information yield and does so effectively when preparing a neural organization. Slope drop or variations, for example, stochastic inclination plummet are frequently utilized for preparing multi-facet organizations and refreshing loads to limit misfortune in view of this productivity.

The back propagation technique works by using the chain rule to compute "the gradient of the loss function with respect to each weight, one layer at a time, iterating backward from the last layer to prevent repetitive calculations. in the chain rule" (Vrugt, (2006)) of intermediate words. It simply refers to the gradient computation algorithm, not how the gradient is employed. It generalises the gradient calculation in the delta rule, which is a single-layer back-propagation method.

2.2.2 Forward Propagation

The information is taken care of the forward way across the organization, as the name suggests. Each secret layer acknowledges the information, examinations it as indicated by the actuation capacity, and afterward sends it on to the following layer. A three-layered neural network is seen in the diagram above. The input and output layers are the first and third levels, respectively. There are two functions in each neuron in the hidden layer:

- Pre-activation function: This function calculates the "weighted sum of the inputs, i.e., the linear transformation of weights" (Baboo, (2010)) in relation to the inputs provided. The neuron decides whether or not to transmit this information on based on the aggregated total and activation function.
- Activation: The activation function receives the determined weighted sum of inputs. A "mathematical function that adds non-linearity to a network is called an activation function" (Baboo, (2010)). Signoid, hyperbolic, tangent, ReLU, and softmax are the four most often used and popular activation functions.

2.2.5 Levenberg-Marquardt Algorithm

The Levenberg-Marquardt calculation, regularly known as the damped least-squares (DLS)method, is utilized to take care of non-direct least square issues in math and PCs. These minimization issues are particularly prevalent in least squares curve fitting. Many software applications employ the LMA to solve generic curve-fitting problems. The LMA only "finds a local minimum, which is not always the same as a global minimum" (Vrugt, (2006)). The LMA interpolates between the Gauss-Newton algorithm (GNA), which means it can find a solution even if it starts very far away from the final minimum in many circumstances.

2.3 Transfer function Used

2.3.1 Sigmoid

A sigmoid is a mathematical function with a distinctive "S"-shaped curve. A sigmoid function is a bounded, differentiable, real function that has a non-negative derivative at each point with exactly one inflection point. The sigmoid function is defined for all real inputs.

A sigmoid capacity is monotonic as a rule and has a chime molded first subsidiary. Any constant, non-consistent, chime molded capacity's indispensable, then again, will be sigmoidal. Therefore, numerous ordinary appropriations have sigmoidal aggregate conveyance capacities. For values under 0, a sigmoid capacity is arched, while for values bigger than 1, it is sunken.

2.4 Programming Language and Visualization Tools Used

2.4.1 MATLAB

Mathworks developed Matrix Laboratory, a proprietary multi-paradigm programming language and mathematical computing environment. Matrix operations, function and data visualisation, algorithm implementation, user interface building, and interfacing with programmes written in other languages are all possible with MATLAB. Despite the fact that MATLAB is basically intended for mathematical calculations, a discretionary tool stash utilizes the MuPAD representative motor to give emblematic figuring capacities. For dynamic and inserted frameworks, Simulink offers graphical multi-space reproduction and model-based plan.

2.4.1.1 Neural Networks in MATLAB:

With instruments and capacities for overseeing enormous informational indexes, MATLAB offers specific tool compartments.

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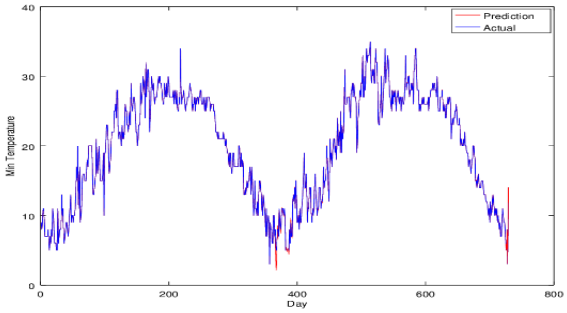
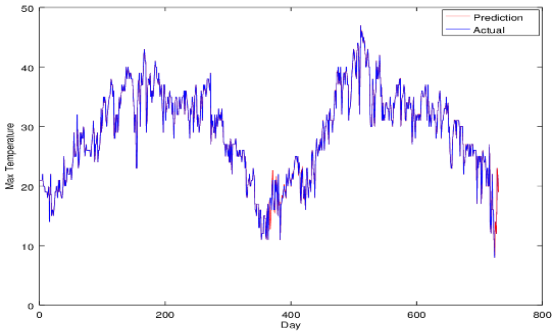
With MATLAB, we can coordinate outcomes into our current applications. Your fake neural organization models can be sent on business frameworks, groups, mists, and installed gadgets utilizing MATLAB. Although each neural network application is unique, the following steps should be followed when building the network:

- Access and set up your information
- Create the counterfeit neural organization
- Configure the organization's sources of info and yields
- Tune the organization limitations, that is loads and inclinations, to expand execution
- Train the organization
- Validate the organizations results
- Integrate the organization into a creation framework

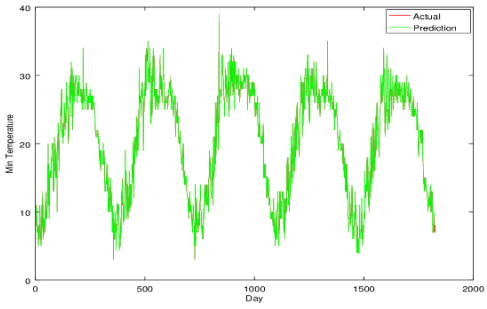
III. Outputs And Visualization

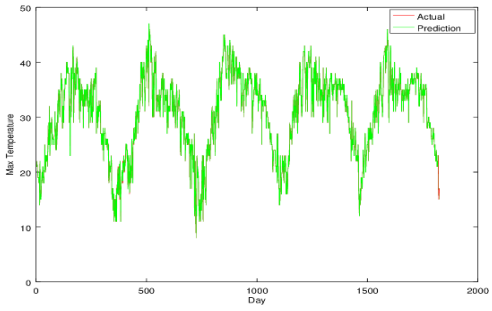
3.1 2-Years Prediction Comparison:



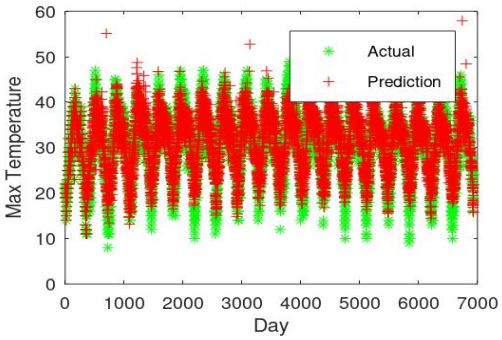


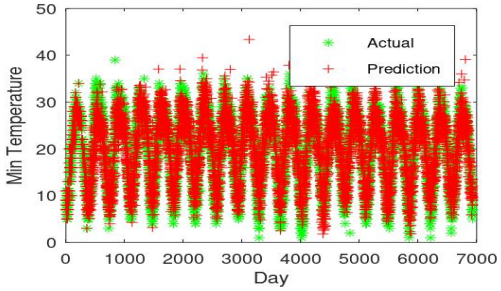
3.2 5-Years Prediction Comparison





3.3 20-Years Prediction Comparison





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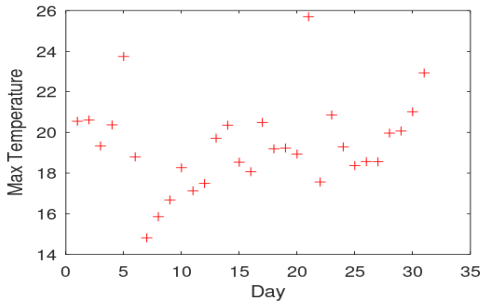
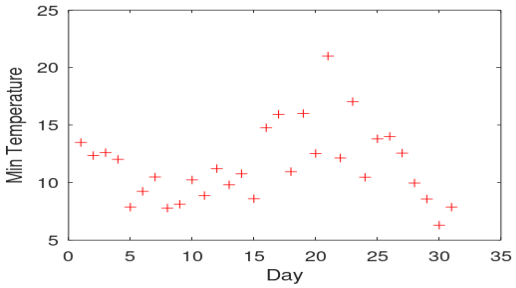
3.4 30-days/1-month Prediction Comparison





IV. CONCLUSIONS

This report offers climate estimating utilizing ANN that is untimely right now. It's anything but a speculative clarification of anticipating climate changes utilizing grouping. We have given the meteorological forecast for coming not many years. Contrasting our outcomes and years, the forecast is very coordinating. Thus the anticipated outcomes are solid however more exploration is surely expected to explain the components, just as to collect the contextual analyses and to foster the precision of expectation. Our disposition towardthe climate forecast is hopeful. Forecast is restricted by obscure conditions and the powerlessness to know quantitative subtleties. Nobody can conflict with nature and battle it; nobody can escape from its loathsome deeds.As the familiar adage goes anticipation is superior to fix, and individuals should take careful steps to diminish the potential outcomes of ranches, business, property harm, and death toll. This work is primarily focused on future improvement instead of utilizing maybe it is through adapting to Geological and Meteorological division through getting valuable data with respect to climate changes. The RMSE esteems got for the year 2015 are by implication the anticipated upsides of the day by day temperature. Since the qualities are available in the secret neurons, the x hub addresses the quantity of covered up neurons holding these qualities. An inclination is the bearing and greatness determined in the neural organization which is utilized to decide the heading where the neurons will in general connection every others.

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