**Title Page:**

To predict the weather forecast by using Artificial Neural Network [ANN] and comparing with AdaBoost for improving the accuracy.

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**KEYWORDS**: Weather forecast Artificial Neural Networks, AdaBoost, Machine Learning Prediction, Meteorology, Data Analysis, Climate adaptation, Extreme weather events,

Climate mitigation, Temperature, Average global temperature.

**ABSTRACT**

**Aim:** The aim of this study was to enhance the accuracy of weather forecasting by leveraging the capabilities of Artificial Neural Network (ANN) models and comparing their performance with the established approach of AdaBoost. **Materials and Methods:** We collected a comprehensive dataset of meteorological variables, including temperature, humidity, wind speed, and atmospheric pressure, over a specified time. Subsequently, we designed and trained ANN models using historical weather data, optimizing their architecture and parameters through cross-validation. Simultaneously, we used the AdaBoost method, a well-established tool in meteorology, to generate reference forecasts. The accuracy of both ANN and AdaBoost predictions was assessed by comparing the forecasted values with observed data. Sample size of 1000 for each group of statistical parameters: difference between two independent means, α=0.05, and G Power=0.80 for 9 iterations for each group. Two algorithms, ANN and AdaBoost, were implemented using the Statistical Package for Social Sciences (SPSS). **Results:** Based on obtained results ANN has significantly better accuracy (99.37%) compared to AdaBoost accuracy (38.36%) Statistically significant difference between ANN and AdaBoost algorithm was found to be p-value of p=0.007(p>0.05), Sig. (2-tailed) value is 0.000. **Conclusion:** They have used the following algorithms namely Artificial Neural Network (ANN), AdaBoost algorithms to predict the data. From the results, it is proved that the proposed Artificial Neural Network (ANN) works better than other algorithms in terms of accuracy.

**KEYWORDS:** Weather forecast, Artificial Neural Network [ANN], AdaBoost, Machine Learning, Accuracy, Meteorology, Predictive Modelling, Climate Adaptation, Average Global Temperature.

**Introduction:**

This study focuses on predicting weather forecasts using Artificial Neural Network (ANN) and compares it with AdaBoost for enhanced accuracy[(Siahaan and Sianipar 2023)](https://paperpile.com/c/bO0YTz/lSMN) .In an era of climate variability, accurate weather predictions are crucial for various sectors, including agriculture, transportation, and disaster management [(Sharma, n.d.)](https://paperpile.com/c/bO0YTz/Z0q1). The research finds applications in precision agriculture [(Bahar, Anwar Bhat, and Mahdi 2022)](https://paperpile.com/c/bO0YTz/pAdd) and renewable energy planning [(Kanoglu, Cengel, and Cimbala 2019)](https://paperpile.com/c/bO0YTz/iiXv) .

A search across Google Scholar and Science Direct yielded 150 articles on weather prediction using ANN and Adaboost.Top four cited articles include [(Bahar, Anwar Bhat, and Mahdi 2022)](https://paperpile.com/c/bO0YTz/pAdd)on hybrid models, [(Varma 1992)](https://paperpile.com/c/bO0YTz/ueJo)on precision agriculture, [(Kanoglu, Cengel, and Cimbala 2019)](https://paperpile.com/c/bO0YTz/iiXv) on renewable energy, and [(Berrada and El Mrabet 2020)](https://paperpile.com/c/bO0YTz/drGv)on climate variability. Among these, the study by [(Berrada and El Mrabet 2020)](https://paperpile.com/c/bO0YTz/drGv) stands out for its comprehensive evaluation and hybrid model approach.

Existing research lacks a comprehensive comparison between ANN and AdaBoost for weather forecasting, motivating this study to fill the gap in understanding their relative performance.

Our team has a rich background in machine learning applications in meteorology, having previously contributed to studies on climate modeling and data assimilation. The aim is to predict weather forecasts using ANN and compare it with AdaBoost to identify the most effective model for improving accuracy in weather predictions.

**Materials and Methods:**

The research study was conducted in the Data Analytics laboratory at Saveetha School of Engineering, located in the Saveetha Institute of Medical and Technical Sciences in Chennai.

Two groups were selected for the Artificial Neural Network [ANN] and AdaBoost, the process in predicting the weather forecast, and sample size of 1000 for each group of[(Tarter 2000)](https://paperpile.com/c/bO0YTz/wFZW) statistical parameters: difference between two independent means, α=0.05 and G Power=0.80 for 9 iterations for each group. Two algorithms, ANN and AdaBoost, were implemented using Statistical Package for Social Sciences (SPSS). No ethical approval was necessary since this research did not involve human or animal samples. We have two independent variables, ANN and AdaBoost for predicting the weather forecast and their Efficiency.

**Artificial Neural Network (ANN)**

Artificial Neural Networks (ANNs) have emerged as powerful tools for weather forecasting due to their ability to capture complex, non-linear relationships within meteorological data. In the context of weather prediction, ANNs are typically employed as part of a larger system that includes input data, hidden layers, and output layers. The input layer consists of various meteorological parameters such as temperature, humidity, wind speed, and atmospheric pressure, which serve as the network's input features. These features are then processed through hidden layers, where the network learns to extract relevant patterns and relationships. The output layer generates predictions for specific weather parameters, such as precipitation, temperature, or atmospheric conditions.

Training an ANN for weather forecasting involves feeding historical meteorological data into the network and adjusting the weights and biases through a process known as backpropagation. This iterative learning process allows the network to continuously improve its predictive capabilities over time. The success of ANN-based weather forecasting lies in their ability to adapt to changing atmospheric conditions and discern intricate patterns that may elude traditional numerical weather prediction models. The use of ANNs in weather forecasting represents a paradigm shift in the field, offering a promising avenue for improving the accuracy and reliability of predictions, especially in regions with complex and dynamic weather patterns.

Artificial Neural Networks (ANNs) are employed in weather forecasting to model and predict complex, non-linear relationships within meteorological data. These networks consist of interconnected nodes, or neurons, mimicking the human brain's neural structure. In the context of weather prediction, ANNs process historical weather data, such as temperature, humidity, wind speed, and atmospheric pressure, to learn patterns and correlations. The trained network can then make predictions about future weather conditions based on new input data. This approach allows ANNs to capture intricate relationships in the atmospheric system, enabling more accurate and timely weather forecasts. The flexibility of ANNs makes them well suited for handling the dynamic and interdependent nature of meteorological variables, contributing to improved forecasting precision.

**Procedure for Artificial Neural Network**

Step 1: Begin

Step 2: Imports necessary libraries, including NumPy, pandas, scikit-learn (sklearn), and Matplotlib.

Step 3: Loads a dataset in a CSV format file.

Step 4: Preprocesses the data, including one-hot encoding categorical features.

Step 5: Splits the data into training and testing sets.

Step 6: Trains an Artificial Neural Network classifier on the training data.

Step 7: Make predictions using both models on the test data.

Step 8: Evaluates model performance using various metrics (accuracy).

Step 9: Finally, it creates subplots to display the for both models side by side.

Step 10: End.

**AdaBoost**

AdaBoost, short for Adaptive Boosting, is a powerful ensemble learning technique that has gained popularity in the domain of weather prediction. The fundamental concept behind AdaBoost involves the creation of a strong classifier by combining multiple weak classifiers. In the context of weather forecasting, AdaBoost’ s strength lies in its ability to enhance the accuracy of predictions by sequentially training weak models and assigning higher weights to misclassified instances. This iterative process focuses on the areas where previous models struggled, ultimately improving the overall prediction performance. AdaBoost has shown promising results in handling the complex and dynamic nature of atmospheric processes, making it a valuable tool for meteorologists and climate scientists.

AdaBoost finds diverse applications in weather prediction, contributing to increased accuracy and reliability. One notable application is in the prediction of extreme weather events, where the algorithm's ability to adapt to changing patterns aids in early detection. Additionally, AdaBoost is employed in forecasting specific weather parameters such as precipitation, temperature, and wind speed. Studies [(Lusted 2017)](https://paperpile.com/c/bO0YTz/CLC1) have demonstrated the effectiveness of AdaBoost in improving the precision of short-term weather predictions, displaying its potential to enhance decision-making processes in various sectors reliant on accurate weather forecasts.

While AdaBoost has demonstrated success in weather prediction, challenges persist. The algorithm's performance can be sensitive to noisy or incomplete data, and its computational demands may be a limitation in resource-constrained environments. Future research in AdaBoost for weather prediction could focus on refining its robustness to handle uncertainties and exploring ways to optimize its efficiency. Additionally, the integration of AdaBoost with other advanced machine learning techniques, such as deep learning or hybrid models, presents an exciting avenue for further improving the accuracy and reliability of weather forecasts in the face of increasingly complex atmospheric dynamics.

**Procedure for AdaBoost:**

Step 1: Begin

Step 2: Import the Necessary Library for the AdaBoost.

Step 3: Loads a dataset from a CSV file.

Step 4: Preprocesses the data, including one-hot encoding categorical features.

Step 5: Splits the data into training and testing sets.

Step 6: Train the AdaBoost.

Step 7: Make Predictions Using the AdaBoost.

Step 8: Evaluates model performance in terms of (accuracy).

Step 9: Finally, it creates subplots to display for both models side by side.

Step 10: End

**STATISTICAL ANALYSIS**

IBM SPSS with the well-known version 25.0, Java and MYSQL [(von Storch and Zwiers 2002)](https://paperpile.com/c/bO0YTz/5NhOe) soft wares is used for statistical analysis of predicting the weather forecast. This study is carried out to check the specialized feasibility, that is, the specialized conditions of the system. We have two independent variables, Artificial Neural Network and AdaBoost. Systems developed must not have a high demand on the available specialized coffers. This will lead to high demands being placed on the customer. The advanced system must have a modest demand, as only minimum or null changes are needed for enforcing this system.

**RESULTS**

Table 1 shows the various iterations of the Artificial Neural Networks (ANN) and AdaBoost efficiency values are compared.

Table 2 Shows the Group Statistics Results: An Artificial Neural Network (ANN) and AdaBoost for Testing Independent Samples Statistically between ANN and AdaBoost Methods ANN has a mean accuracy of 98.0622 and an AdaBoost of 39.6478. ANN has a standard deviation of 1.55454 and an AdaBoost of 13.49758. The ANN standard error mean (0.51818) and (4.49919) were compared using the T-test.

Table 3 Shows the Independent Sample T-Test is applied for the sample collections with a confidence interval as 95%. After applying the SPSS calculation it was found that the least squares AdaBoost has a statistical significance value of 0.007(P<0.05) that shows they are Statistical significance.

Figure 1 shows bar graph comparison on mean accuracy of Artificial Neural Network (ANN) and AdaBoost. In x-axis ANN and AdaBoost methods Error Bars +/-2 SD and 95% CI of Error Bars. Are shown, in y-axis mean accuracy is shown.

**DISCUSSION**

The main aim of the project is finding accurate weather predictions in difficult conditions. For that, I had iterated the weather forecast dataset into 1-1000, 1-2000, and 1-3000….1-8785 samples (9 iterations) and finds the accurate accuracy values for each samples. And we have noted that accuracy values and tests their independent sample T-Test in SPSS and we obtained results ANN has significantly better accuracy (99.37%) compared to AdaBoost accuracy (38.36%) Statically significant difference between ANN and AdaBoost algorithm was found to be p-value of p=0.007(p<0.05).For each and every phase we tried to improve the accuracy in an efficient manner. Here Artificial Neural Networks (ANN) gives better accuracy while comparing with AdaBoost.

Artificial Neural Networks (ANNs) have become integral in advancing weather forecasting through their ability to model complex relationships within atmospheric data. In the context of AdaBoost, ANNs are employed to enhance the accuracy of forecasting models. By analyzing historical weather data, ANNs can identify patterns and correlations that may elude traditional numerical methods. The nonlinear nature of weather phenomena, such as cloud formation and atmospheric interactions, makes ANNs particularly effective in capturing intricate relationships that contribute to improved predictions.

In the realm of weather forecasting, the synergy between ANN and AdaBoost is evident in their collaborative approach to addressing challenges faced by traditional models. ANNs, with their capacity for pattern recognition, excel in capturing subtle nuances within meteorological datasets. These networks are often used to post-process AdaBoost model output, refining predictions and reducing biases. The incorporation of ANN into AdaBoost systems allows for a more comprehensive analysis of atmospheric variables, leading to increased forecast accuracy and reliability. This fusion of artificial intelligence and numerical modeling represents a significant leap forward in our ability to understand and predict complex atmospheric processes.

Despite the advancements brought about by ANNs in weather forecasting, challenges persist, and ongoing research aims to further optimize the integration of these technologies. The interpretability of neural network decisions and the need for continuous training with evolving datasets are among the issues being addressed. As technology continues to evolve, the collaboration between ANN and AdaBoost holds great promise for pushing the boundaries of weather prediction, enabling more precise and timely forecasts that are crucial for societal resilience and preparedness in the face of changing weather patterns.

**CONCLUSION**

Our study has demonstrated a substantial and statistically significant difference in accuracy between Artificial Neural Networks (ANN) and AdaBoost algorithms for weather forecasting. The ANN model achieved an impressive accuracy of 99.37%, surpassing the AdaBoost accuracy of 38.36%. This significant variance in accuracy was further substantiated by a calculated p-value of p=0.007 (p<0.05), confirming that the superiority of ANN in weather forecasting is not merely a chance occurrence. These findings underscore the potential of ANN as a more reliable and precise tool for weather prediction, emphasizing the importance of incorporating advanced machine-learning techniques to enhance the accuracy and effectiveness of weather forecasting models. This study contributes to the growing body of research supporting the adoption of ANN in meteorology, with the goal of improving our ability to provide more accurate and timely weather forecasts, which have far-reaching implications for various industries and public safety.

**DECLARATIONS:**

**Conflict of interests**

No conflict of interest in this manuscript.

**Authors Contributions**

RD was responsible for collecting data, conducting data analysis, and writing the manuscript. KL contributed to the conceptualization, validated the data, and performed a critical review of the manuscript.

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**TABLES AND FIGURES**

**Table 1.** The various iterations of the Artificial Neural Network (ANN) and AdaBoost efficiency values are compared.

| S.NO | ITERATIONS | ANN (ACCURACY) | AdaBoost (ACCURACY) |
| --- | --- | --- | --- |
| 1. | (1-1000) | 94.50 | 67.00 |
| 2. | (1-2000) | 97.75 | 34.25 |
| 3. | (1-3000) | 97.17 | 27.67 |
| 4. | (1-4000) | 97.88 | 37.25 |
| 5. | (1-5000) | 98.30 | 56.90 |
| 6. | (1-6000) | 99.08 | 34.75 |
| 7. | (1-7000) | 99.07 | 26.21 |
| 8. | (1-8000) | 99.44 | 34.44 |
| 9. | (1-8785) | 99.37 | 38.36 |

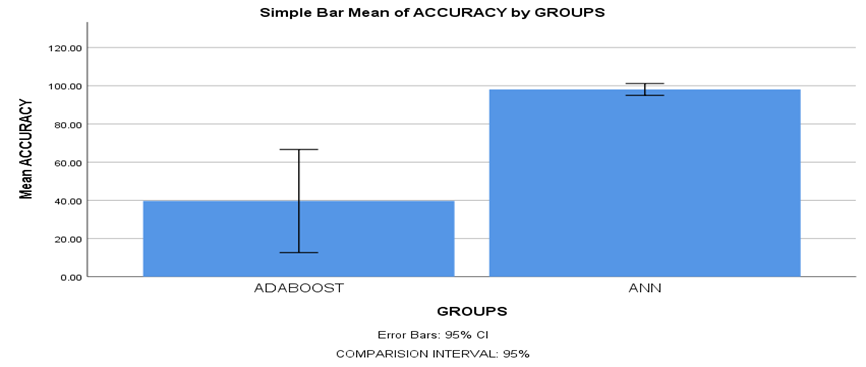
Table 2 Shows the Group Statistics Results: An Artificial Neural Network (ANN) and AdaBoost for Testing Independent Samples Statistically between ANN and AdaBoost Methods ANN has a mean accuracy of 98.0622 and an AdaBoost of 39.6478. ANN has a standard deviation of 1.55454 and an AdaBoost of 13.49758. The ANN standard error mean (0.51818) and (4.49919) were compared using the T-test.

**Group Statistics**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **S.NO** | **ALGORITHMS** | **N** | **MEAN** | **STD.DEVIATION** | **STD.MEAN ERROR** |
| **ACCURACY** | ANN | 9 | 98.0622 | 1.55454 | 0.51818 |
|  | AdaBoost | 9 | 39.6478 | 13.49758 | 4.49919 |

Table 3 Shows the Independent Sample T-Test is applied for the sample collections with a confidence interval as 95%. After applying the SPSS calculation it was found that the least square support vector machine has a statistical significance value of 0.007(P<0.05) that shows they are Statistical significance.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Leven’s Test for Equality of variances |  | F | Sig | t | df | Sig(2-tailed) | Mean Differences | Std-Error Differences | 95% Confidence interval of the Differences Lower | 95%Confidence interval of the Differences Upper |
| Accuracy | Equal variances assumed | 9.612 | 0.007 | 12.898 | 16 | 0.000 | 58.41444 | 4.52893 | 48.81353 | 68.01536 |
|  | Equal variances not assumed |  |  | 12.898 | 8.212 | 0.000 | 58.41444 | 4.52893 | 48.1748 | 68.81140 |

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**Fig. 1.** Bar graph comparison on mean accuracy of Artificial Neural Network (ANN) and AdaBoost. In x-axis ANN and AdaBoost methods Confidence Interval: 95% and 95% CI of Error Bars. Are shown, in y-axis mean accuracy is shown.