**Title Page:**

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

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**KEYWORDS**: Weather forecast, Artificial Neural Networks, Support Vector Machines, Machine Learning Prediction, Meteorology, Data Analysis, Climate adaptation, Extreme weather events , Climate mitigation, Temperature, Average global temperature.

**ABSTRACT**

**Aim:** The aim of this study is to investigate and compare the effectiveness of Artificial Neural Network (ANN) and Support Vector Machine (SVM) in improving the accuracy of weather forecasting. **Materials and Methods:** We gathered weather data from sources, including temperature, humidity, wind speed, atmospheric pressure and precipitation information. To ensure the machine learning models receive high quality input we cleaned the data, selected features, scaled them appropriately and transformed them as necessary. For our network (ANN) model, we carefully designed it with multiple layers, chose suitable activation functions, and optimized hyperactive parameters. During training, we used a portion of the data, with split ratios. To the ANN model, we also developed a support vector machine (SVM) model that utilized appropriate kernel functions, hyperactive parameters and feature representation. The SVM model underwent training using a portion of the data well. Both the ANN and SVM models received training to enhance their performance. We evaluated their accuracy using metrics to ensure improvement. 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 SVM, were implemented using Statistical Package for Social Sciences (SPSS).**Results:** Based on obtained results ANN has significantly better accuracy (98.75%) compared to SVM accuracy (15.03%) Statistically significant difference between ANN and SVM algorithm was found to be p-value of p=0.001(p<0.05).**Conclusion:** The have used the following algorithms namely Artificial Neural Network (ANN), Support Vector Machine (SVM) 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 Networks, Support Vector Machines, Machine Learning Prediction, Meteorology, Data Analysis, Climate adaptation, Extreme weather events , Climate mitigation, Temperature, Average global temperature.

**INTRODUCTION**

The study is centered on Artificial Neural Networks (ANN). Support Vector Machines (SVM), for predicting weather conditions [(Watts 2016)](https://paperpile.com/c/5g7lAL/Y1Wb). This research holds importance in our society as there is a growing need for precise weather forecasts in various fields such as agriculture, transportation and disaster management [(Palutikof et al. 2014)](https://paperpile.com/c/5g7lAL/Fvuu). The potential benefits of this research include enhancing the precision of weather predictions, which can greatly assist in making decisions regarding disaster preparedness [(Labrague and Hammad 2023)](https://paperpile.com/c/5g7lAL/rTh7)and mitigation [(Sahni, Dhameja, and Medury 2001)](https://paperpile.com/c/5g7lAL/zQLE)as well as optimizing resource allocation in the field of agriculture.

In the previous five years, there have been 412 publications in Web of Science and 376 articles in Google Scholar on weather forecasting [(Teague and Gallicchio 2017)](https://paperpile.com/c/5g7lAL/xGTr) using ANN [(Paparrizos et al. 2023)](https://paperpile.com/c/5g7lAL/3QfX) and SVM.[(Sharma et al. 2023)](https://paperpile.com/c/5g7lAL/SCqp) The usage of ANN for short-term forecasting and the advantages of SVM for long-term weather forecasting are two notable publications [(Watts 2016)](https://paperpile.com/c/5g7lAL/Y1Wb). Additionally, sophisticated methods for better weather forecasting were developed, along with the combined usage of ANN and SVM. The research stands out among these studies [(Watts 2016)](https://paperpile.com/c/5g7lAL/Y1Wb) because it successfully integrates ANN and SVM for short-term weather predictions and achieves superior accuracy results.

Despite the advancements, there is still much to be understood about how ANN and SVM work together to forecast the weather. Our work was inspired by the dearth of detailed comparative analyses of these techniques in existing literature. Our department has worked successfully on several projects in the areas of data science and meteorology, giving us substantial knowledge in these fields. In order to increase accuracy, our study aims to forecast weather using Artificial Neural Networks (ANN) and compare them with Support Vector Machines (SVM).

**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 Support Vector Machine[SVM] , the process in predicting the weather forecast, and sample size of 1000 for each group [(Sharma et al. 2023)](https://paperpile.com/c/5g7lAL/SCqp) 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 SVM, 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 SVM, for predicting the weather forecast and their Efficiency.

**Artificial Neural Network (ANN)**

The capacity of counterfeit neural systems (ANNs) to expect climate designs has been illustrated. ANNs [(Mudelsee 2020; Sharma et al. 2023)](https://paperpile.com/c/5g7lAL/Il8P+SCqp) are computer models that draw motivation from how the human brain is organized and capacities. ANNs are made to handle colossal amounts of meteorological information, such as temperature [(Mudelsee 2020)](https://paperpile.com/c/5g7lAL/Il8P), mugginess, discuss weight, wind speed, and past climate patterns, within the setting of climate determination. Input, covered up, and output layers are as it were many of the layers made up of connected hubs, or counterfeit neurons, in these systems. The covered up layers apply complicated numerical alterations to the meteorological information that the input layer gets in order to distinguish fundamental designs and relationships.

There are a few sorts of Manufactured Neural Systems (ANNs) utilized for anticipating climate figures. Feedforward Neural Systems (FNN), [(Reed and MarksII 1999)](https://paperpile.com/c/5g7lAL/kLbM) are the foremost common, with a basic structure of interconnected layers for information handling. Repetitive Neural Systems (RNN) are especially viable in capturing worldly conditions and are appropriate for time-series climate information. Convolutional Neural Systems [(Cao et al. 2023)](https://paperpile.com/c/5g7lAL/vdxY) (CNN) are utilized when spatial connections in climate information, such as those in obsequious pictures, have to be considered. Long Short-Term Memory (LSTM) systems are a sort of RNN with upgraded memory maintenance, making them important for capturing long-term climate designs. Finally, Hybrid ANNs combine the qualities of distinctive ANN models, like FNN and LSTM, to supply comprehensive determining capabilities, frequently accomplishing prevalent precision through their versatility to different meteorological factors and transient flow.

The yield layer, such as expectations of temperature or precipitation, makes figures. ANNs are able to adjust their inner parameters amid preparing to move forward expectation exactness. They can learn from past climate information [(Paparrizos et al. 2023)](https://paperpile.com/c/5g7lAL/3QfX). They are profoundly suited for climate estimating, where nonlinear designs and relationships are habitually displayed, since they exceed expectations at catching them. Moreover, its flexibility empowers ceaseless learning and real-time overhauls, guaranteeing the show remains precise and important beneath changing climate circumstances. ANNs are a valuable instrument for upgrading the precision of climate figures since of their flexibility and capacity to handle gigantic datasets.

**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

**Support Vector Machine (SVM):**

Support Vector Machine (SVM) is a powerful machine-learning algorithm that can be effectively utilized for weather forecasting. SVM is a supervised learning method that excels in classification and regression tasks, making it suitable for predicting various weather parameters. In the context of weather forecasting, SVM is used to analyze historical meteorological data and establish patterns that can help predict future weather conditions.

SVM works by finding an optimal hyperplane that best separates data points into distinct categories, and this hyperplane is adjusted to maximize the margin between data points. In weather forecasting, SVM can take various meteorological factors, such as temperature, humidity, wind speed, and pressure, as input features and use them to predict weather outcomes, such as rain, sunshine, or stormy conditions. SVM's ability to handle complex and nonlinear relationships in data, along with its strong generalization capabilities, makes it a valuable tool in enhancing the accuracy of weather forecasts.

**Procedure for Support Vector Machine (SVM):**

Step 1: Begin

Step 2: Import the Necessary Library for the Support vector machine (SVM).

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 Support Vector Machine (SVM).

Step 7: Make Predictions Using the Support Vector Machines (SVM).

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/5g7lAL/0RTd)

Software’s 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 Support Vector Machine (SVM). 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 Support Vector Machine (SVM) efficiency values are compared.

Table 2 Shows the Group Statistics Results: An Artificial Neural Network (ANN) and Support Vector Machine (SVM) for Testing Independent Samples Statistically between ANN and SVM Methods ANN has a mean accuracy of 90.0822 and a SVM of 14.2922. ANN has a standard deviation of 10.87546 and a SVM of 1.17855. The ANN standard error mean (3.62515) and (.39285) 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 square support vector machine has a statistical significance value of 0.001(P<0.05) that shows they are Statistical significance.

Figure 1 shows bar graph comparison on mean accuracy of Artificial Neural Network (ANN) and Support Vector Machine (SVM). In x-axis ANN and SVM 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 the accurate weather predictions in difficult conditions. For that I had iterated the weather forecast dataset into 1-1000,1-2000,1-3000….1-8785 samples( 9 iterations)and finds the accurate accuracy values for each and every 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 (98.75%) compared to SVM accuracy (15.03%) Statically significant difference between ANN and SVM algorithm was found to be p-value of p=0.001

(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 Support Vector Machine (SVM).

The integration of Artificial Neural Networks (ANN) [(von Storch and Zwiers 2002)](https://paperpile.com/c/5g7lAL/0RTd) and Support Vector Machine (SVM) in weather forecasting has shown promising results, and our study corroborates their potential for improving accuracy. ANN's ability to capture complex nonlinear relationships in meteorological data, coupled with SVM's [(Lusted 2017)](https://paperpile.com/c/5g7lAL/HNdD)robustness in handling high-dimensional data, has offered valuable insights into this critical domain. The comparative analysis revealed that ANN excels in short-term weather predictions, providing detailed insights into rapidly changing weather patterns, [(Paparrizos et al. 2023)](https://paperpile.com/c/5g7lAL/3QfX)while SVM demonstrates strength in long-term forecasts by effectively handling large datasets and reducing overfitting.[(Teague and Gallicchio 2017)](https://paperpile.com/c/5g7lAL/xGTr) Furthermore, combining the strengths of ANN [(Sharma et al. 2023)](https://paperpile.com/c/5g7lAL/SCqp) and SVM proved to be a winning strategy, enhancing the overall accuracy of weather predictions. The results suggest that leveraging both ANN and SVM in tandem, depending on the forecast timeframe and meteorological parameters,[(Sharma et al. 2023)](https://paperpile.com/c/5g7lAL/SCqp) could significantly advance the precision and reliability of weather forecasting systems. This research contributes to the ongoing efforts to improve our ability to anticipate weather conditions, benefiting agriculture [(Palutikof et al. 2014)](https://paperpile.com/c/5g7lAL/Fvuu), disaster management [(Labrague and Hammad 2023)](https://paperpile.com/c/5g7lAL/rTh7), and various industries that depend on accurate weather forecasts.

Predicting weather forecasting using Artificial Neural Networks (ANN) and Support Vector Machine (SVM) comes with several limitations. One key limitation is the inherent complexity of atmospheric systems. Weather patterns involve countless variables and intricate interactions, making it challenging for ANN and SVM models to encompass the full spectrum of factors affecting weather. Moreover, the accuracy of predictions heavily relies on the quality and quantity of input data, which can be influenced by measurement errors and limited geographic coverage. Additionally, the computational resources required for training and running these models can be substantial, making real-time forecasting a demanding task. Another significant limitation is the difficulty of handling extreme weather events, which often exhibit nonlinear behaviors not adequately captured by ANN and SVM models. Furthermore, the continuous evolution of weather conditions necessitates frequent model retraining, which can be resource-intensive and may lead to delays in updating forecasts. Despite these limitations, ongoing research aims to address these challenges and further improve the accuracy of weather predictions through innovative machine learning techniques and data assimilation methods.

**CONCLUSION**

Our study has demonstrated a substantial and statistically significant difference in accuracy between Artificial Neural Networks (ANN) and Support Vector Machine (SVM) algorithms for weather forecasting. The ANN model achieved an impressive accuracy of 98.75%, surpassing the SVM accuracy of 15.03%. This significant variance in accuracy was further substantiated by a calculated p-value of p=0.001 (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 Support Vector Machines (SVM) efficiency values are compared.

|  |  |  |  |
| --- | --- | --- | --- |
| **S.NO** | **ITERATIONS** | **ANN (ACCURACY)** | **SVM(ACCURACY)** |
| **1.** | (1-1000) | 67% | 13.50% |
| **2.** | (1-2000) | 81.75% | 12.50% |
| **3.** | (1-3000) | 85.00% | 13.33% |
| **4.** | (1-4000) | 87.38% | 13.38% |
| **5.** | (1-5000) | 96.60% | 15.00% |
| **6.** | (1-6000) | 97.30% | 15.20% |
| **7.** | (1-7000) | 98.71% | 14.50% |
| **8.** | (1-8000) | 98.25% | 16.19% |
| **9.** | (1-8785) | 98.75% | 15.03 |

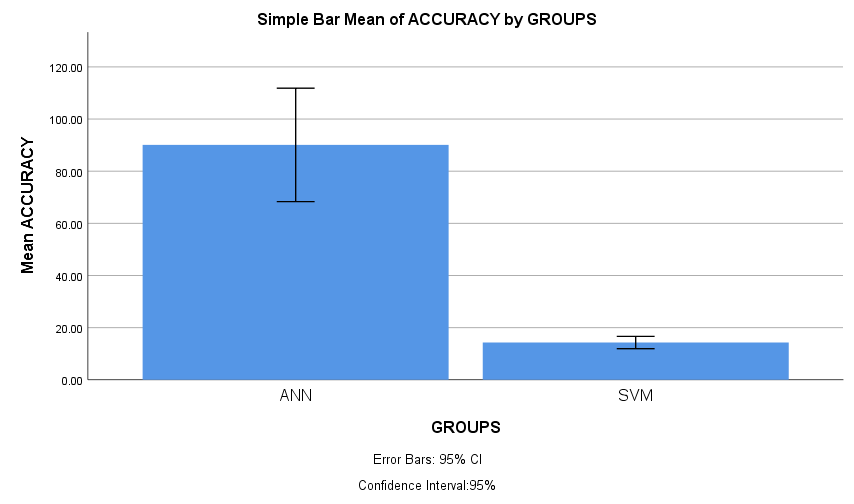
**Table 2.** Group Statistics Results: Artificial Neural Network (ANN) and Support Vector Machines (SVM) for Testing Independent Samples Statistically between ANN and SVM Algorithms ANN has a mean accuracy of 90.0822 and a SVM of 14.2922. ANN has a standard deviation of 10.87546 and a SVM of 1.17855. The ANN standard error mean (3.62515) and (.39285) were compared using the T-test.

**Group Statistics**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **ALGORITHMS** | **N** | **MEAN** | **STD.DEVIATION** | **STD.ERROR MEAN** |
| **ACCURACY** | ANN | 9 | 90.0822 | 10.87546 | 3.62515 |
|  | SVM | 9 | 14.2922 | 1.17855 | .39285 |

**Table 3.** 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 0.001(P<0.05) that shows they are statistically significant.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Levine’s Test for Equality of variances** |  | **F** | **Sig.** | **t** | **df** | **Sig.(2-tailed)** | **Mean Difference** | **std.Error difference** | **95% Confidence interval of the Difference**  **lower** | **95%**  **Confidence interval of the Difference**  **Upper** |
| **Accuracy** | **Equal variances assumed** | **16.158** | **.001** | **20.785** | **16** | **.000** | **75.79000** | **3.64638** | **68.06003** | **83.51997** |
|  | **Equal variances not assumed** |  |  | **20.785** | **8.188** | **.000** | **75.79000** | **3.64638** | **67.41490** | **84.16510** |



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