WEATHER FORECASTING USING AUTOREGRESSIVE MODELS

V. Sarala [1], G. Sushma,

[1]**Assistant professor, MCA DEPT,** Dantuluri Narayana Raju College**, Bhimavaram, Andharapradesh**
Email:- vedalasarala21@gmail.com
[2]**PG Student of MSc(cs), Dantuluri** Narayana Raju College**, Bhimavaram, Andharapradesh**
Email:- sushmagalinki95@gmail.com

ABSTRACT

Weather forecasting is a critical application in meteorology, impacting various sectors such as agriculture, aviation, and disaster management. Traditional forecasting methods rely heavily on numerical weather prediction (NWP) models, which are computationally intensive and require significant observational data. In contrast, statistical approaches, particularly Autoregressive (AR) models, offer a more computationally efficient alternative. This paper explorestheefficacyofARmodelsinshort-termweatherforecasting.Weemployautoregressive integrated moving average (ARIMA) models to predict temperature and precipitation, leveraging historical weather data. The study involves model training on time series data from multiple weather stations and evaluating the predictive performance against actual observations. Results indicate that AR models, while simpler, provide competitive accuracy for short-term forecasts when compared to complex NWP models. Additionally, the research highlights the importance of parameter selection and model tuning in enhancing forecast reliability. The findings suggest that AR models can serve as a valuable tool in the meteorologist's toolkit, particularly in resource-constrained environments where computational resources are limited. Future work will focus on integrating AR models with machine learning techniques to further improve predictive accuracy and extend the forecasting horizon.

1 INTRODUCTION

Weather forecasting plays a crucial role in various aspects of human activity, ranging from agriculture and transportation to emergency management and daily decision-making. Accurate weather predictions enable farmers to optimize crop management, airlines to ensure flight safety, and governments to prepare for natural disasters, thereby mitigating potential damages and losses.

Traditional weather forecasting methods predominantly rely on Numerical Weather Prediction (NWP) models. These models simulate the atmosphere's behavior by solving complex mathematical equations based on physical principles. While NWP models have significantly improved forecast accuracy over the decades, they are computationally intensive and require substantial observational data and processing power. Consequently, their application in resource- limited settings can be challenging.

Literature Survey

Title: A Review of Weather Forecasting Models Based on Machine Learning and Data Mining Approaches

Description: This paper provides a comprehensive review of various machine learning and data mining approaches used in weather forecasting. The authors discuss the advantages and limitations of different models, including autoregressive models, and compare their performance with traditional NWP models. The review highlights the growing importance of computational efficiency and the potential of machine learning techniques in improving forecast accuracy.

3 IMPLEMENTATION STUDY

EXISTING SYSTEM:

Weather forecasting has traditionally been dominated by Numerical Weather Prediction (NWP) models. These models use mathematical simulations of the atmosphere's physical processes to predict future weather conditions. NWP models rely on complex equations that describe atmospheric dynamics, thermodynamics, and radioactive transfer. These equations are solved using high-performance computing systems, requiring substantial computational power and extensive observational data from satellites, weather stations, and other sources.

Disadvantages:

While Numerical Weather Prediction (NWP) models are the cornerstone of modern weather forecasting due to their detailed and physically grounded simulations, they come with significant drawbacks. The primary disadvantage of NWP models is their computational intensity. Running these models requires substantial processing power and time, often necessitating the use of supercomputers. This makes real-time forecasting challenging and costly, limiting the accessibility of high-quality forecasts to organizations with substantial computational resources.

Proposed System & alogirtham

The proposed system for weather forecasting leverages Autoregressive Integrated Moving Average (ARIMA) models to provide a more efficient and accessible alternative to traditional Numerical Weather Prediction (NWP) models. The system aims to enhance short-term weather forecasting accuracy while addressing the computational and data limitations inherent in current forecasting methods. By utilizing historical weather data and advanced statistical techniques, the proposed system seeks to deliver reliable forecasts with reduced computational overhead.

4.1 Advantages:

The proposed system for weather forecasting, which leverages Autoregressive Integrated Moving Average (ARIMA) models and integrates machine learning techniques, offers several significant advantages over traditional forecasting methods. These benefits highlight the system's potential to improve forecast accuracy, efficiency, and accessibility.

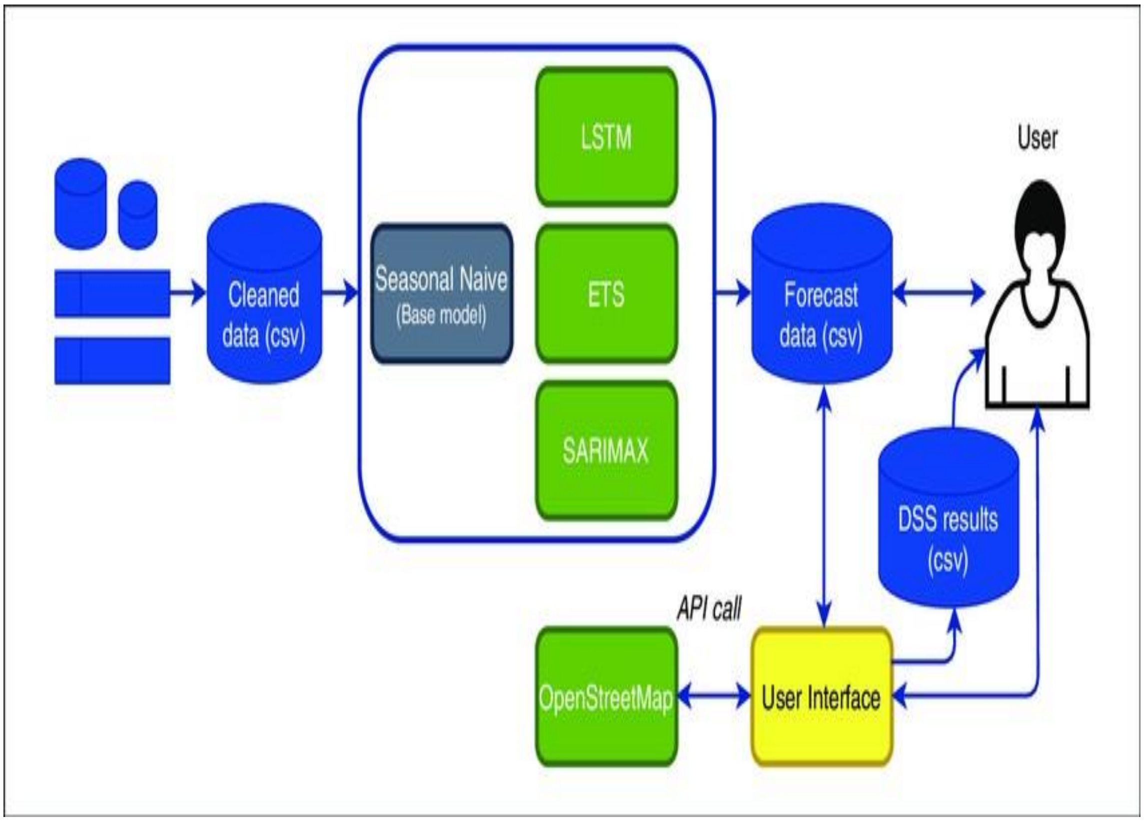


Fig:3.1 System Architecture

IMPLEMENTATION

1. **Data Preprocessing**: Prepare the textual data by removing noise, such as special characters, punctuation, and stop words. Tokenize the text into sentences or paragraphs to facilitate sentiment analysis and summarization.
2. **Sentiment Analysis Model**: Implement or utilize pre-trained sentiment analysis models capable of accurately detecting the sentiment polarity (positive, negative, neutral) of each sentence or paragraph in the text. Consider employing advanced techniques such as deep learning-based models or transformer architectures for improved accuracy.
3. **Summarization Model**: Implement a text summarization model capable of

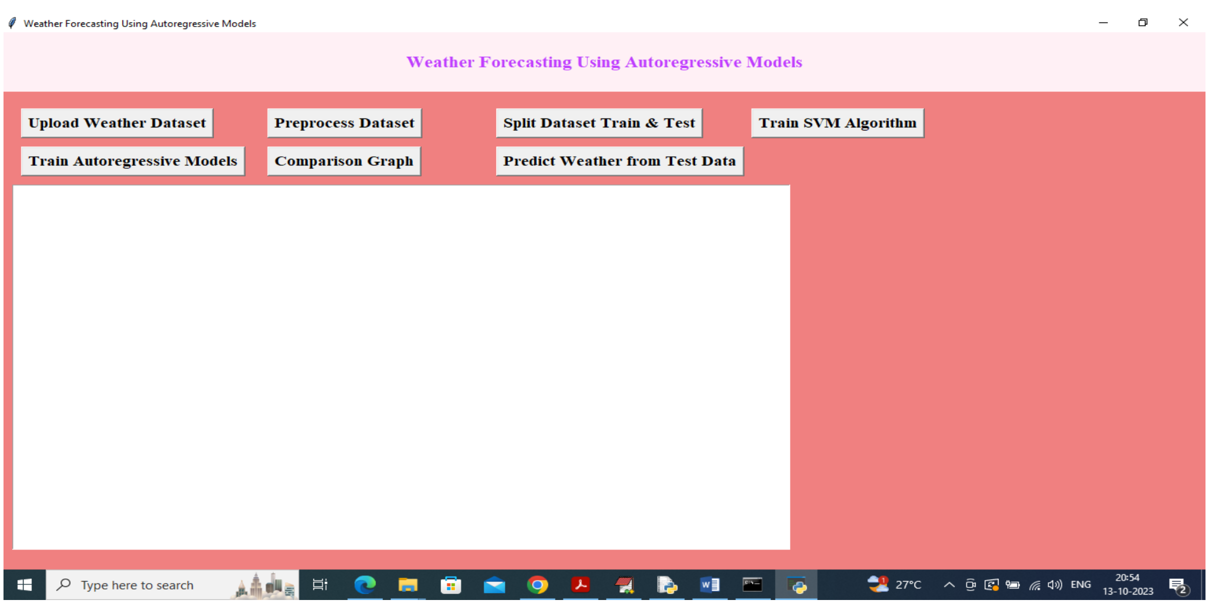
generating concise summaries while incorporating sentiment information. Explore both extractive and abstractive summarization techniques, considering factors such as coherence, in formativeness, and sentiment preservation.

4. **Integration**: Integrate the sentiment analysis module with the summarization module to leverage sentiment information during the summarization process. Design mechanisms to prioritize or adjust the inclusion of sentences based on their sentiment polarity to ensure that the generated summaries reflect the emotional context of the original text.
5. **Evaluation**: Evaluate the performance of the implemented system using standard metrics such as ROUGE (Recall-Oriented Understudy for Gifting Evaluation) for summarization quality and sentiment classification accuracy metrics for sentiment analysis. Conduct thorough evaluations using benchmark datasets to assess the effectiveness and robustness of the system.

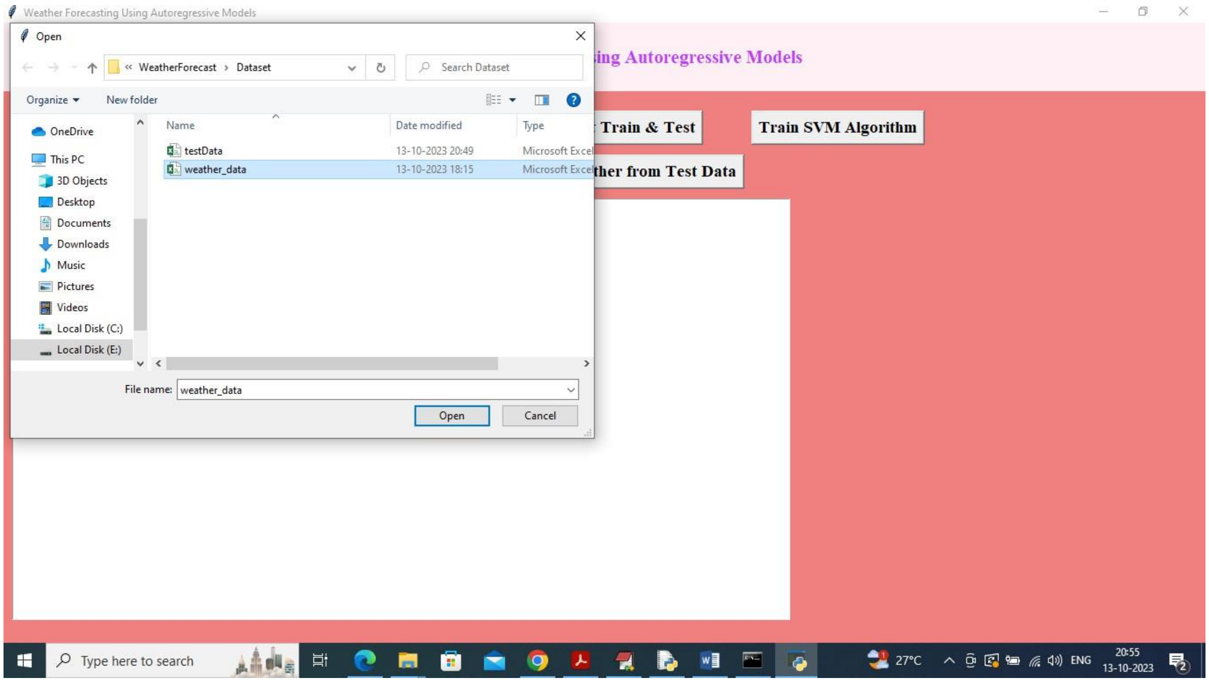
5 RESULTS AND DISCUSSION

8. SCREEN SHOTS

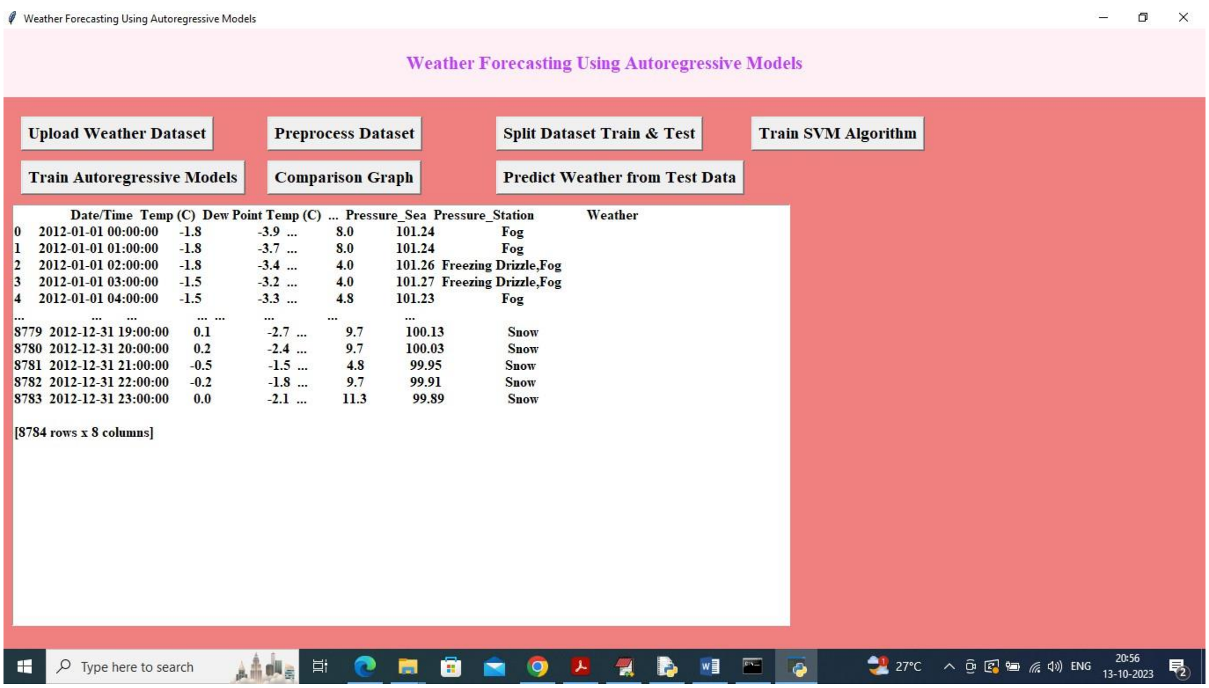
To run project double click on'run.bat'file to get below screen



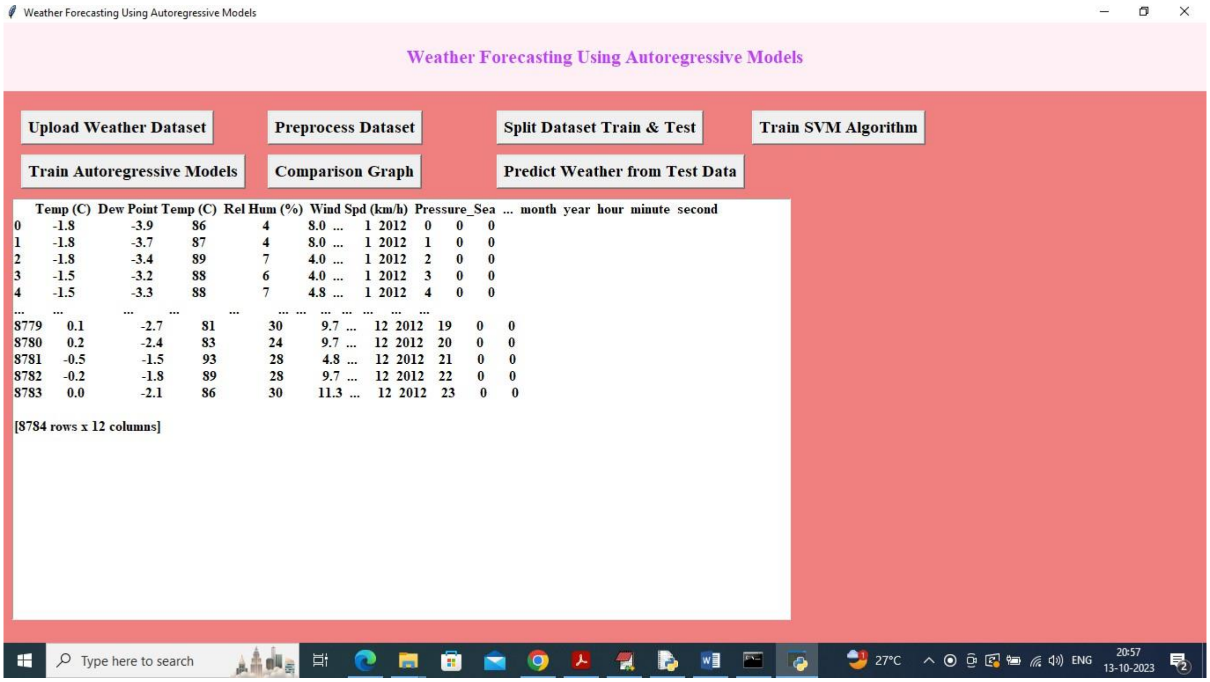
In above screen click on 'Upload Weather Dataset' button to upload dataset to application and get below output



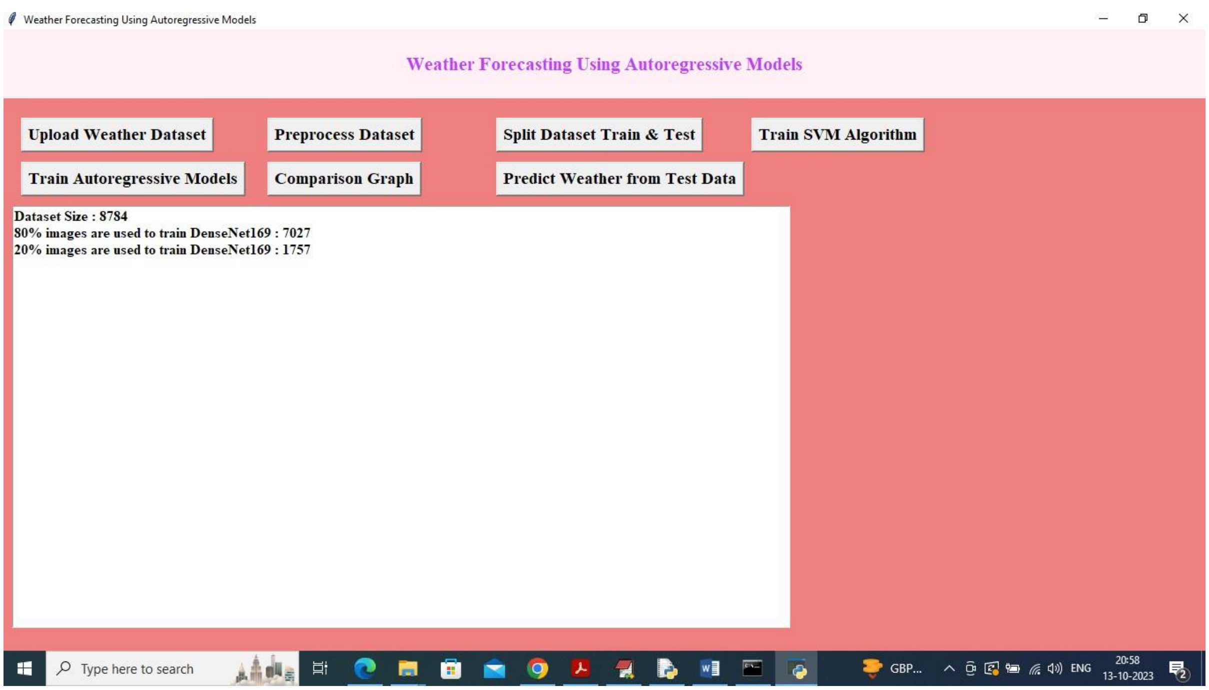
In above screen selecting and uploading 'Weather Dataset' and then click on 'Open' button to load dataset and get below output



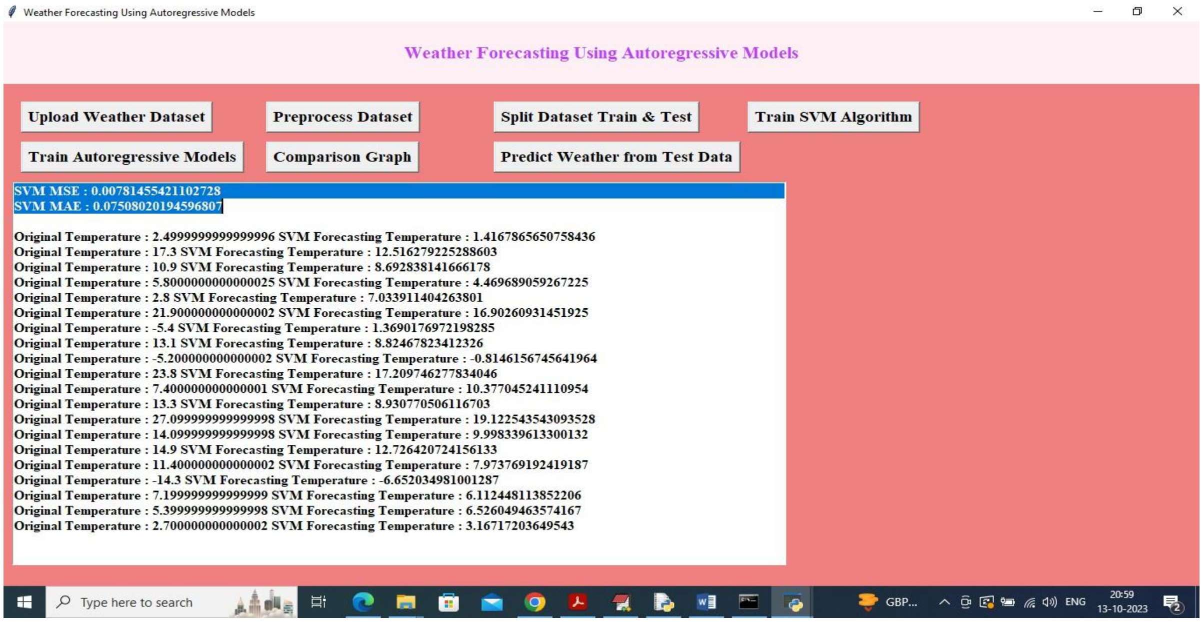
In above screen dataset loaded and in dataset we have numeric and non-numeric values and now click on 'Pre-process Dataset' button to convert entire dataset into numeric and get below output



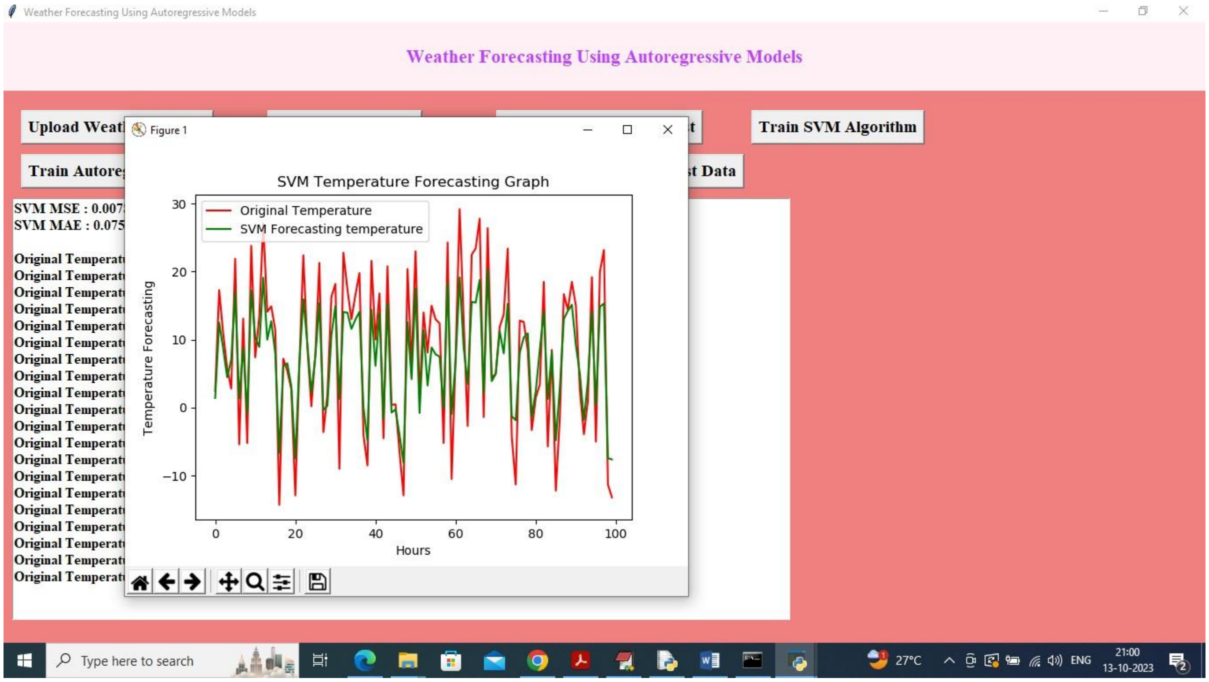
Inabovescreendatasetconvertedtonumericformatandthenclickon'SplitdatasetTrain& Test' button to split dataset into train and test and then will get below output



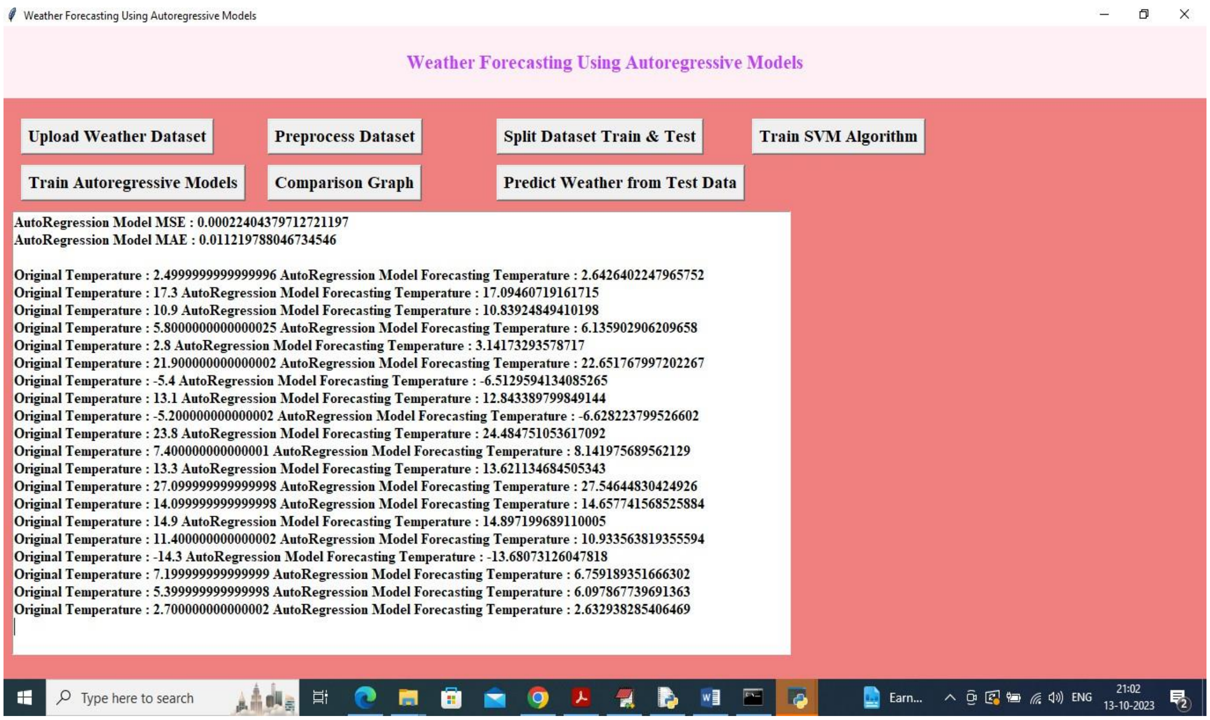
In above screen we can see data set size and then train and test size and the click on 'Train SVM Algorithm' button to get below output



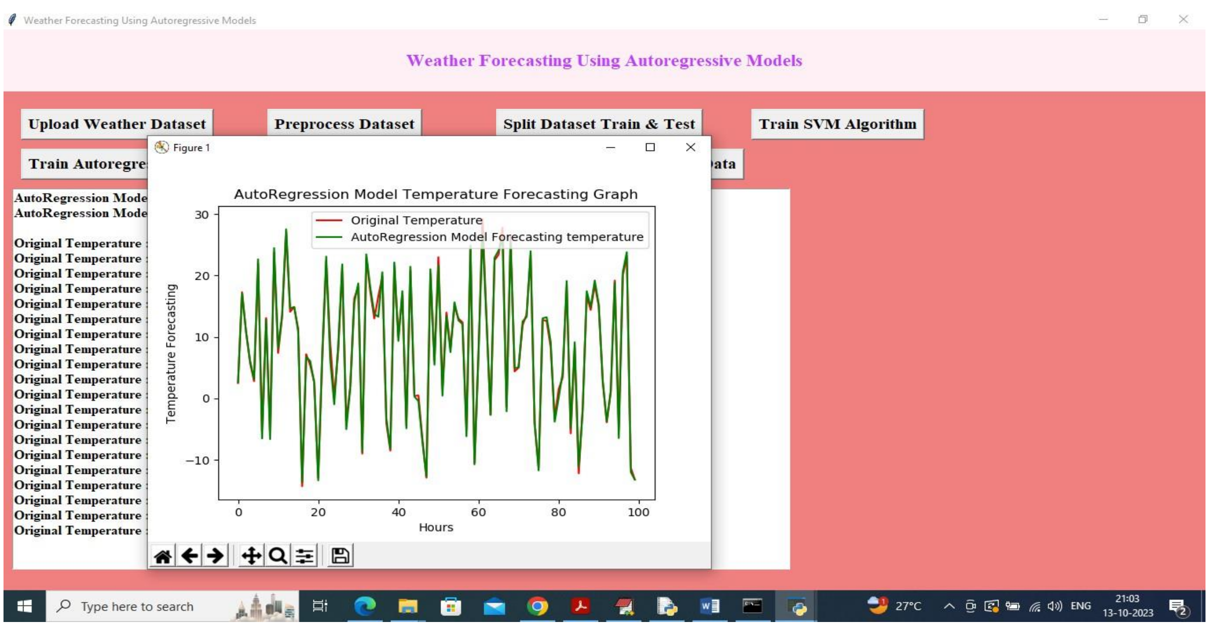
In above screen in first two lines we can see SVM MSE and MAE values and then in next line we can see test data temperature and SVM predicted temperature and by seeing both values we can see there is not much difference between original and predicted values and can say SVM is little accurate in forecasting and below is the SVM prediction graph



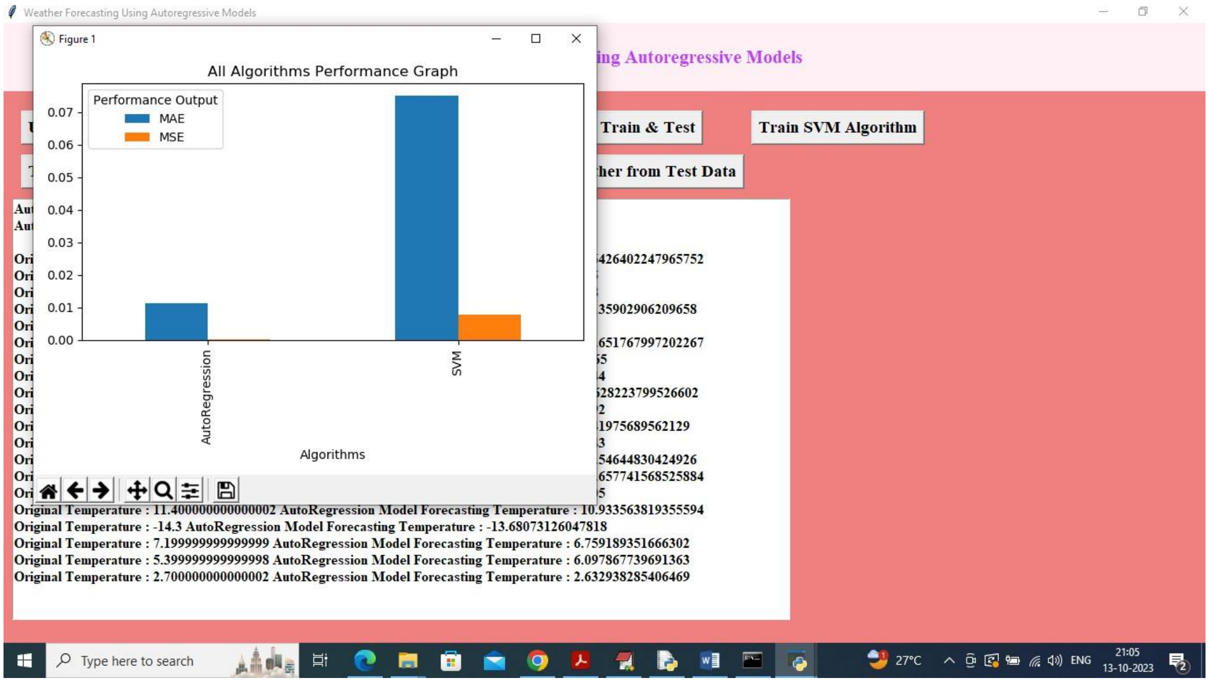
In above SVM forecast graph x-axis represents HOURS and y-axis represents weather temperature and in graph red line represents True temperature and green line represents SVM forecast temperature and in above graph both lines are overlapping with some gaps so SVM is not much accurate and now close above graph and then click on 'Train Autoregressive Models' button to train model



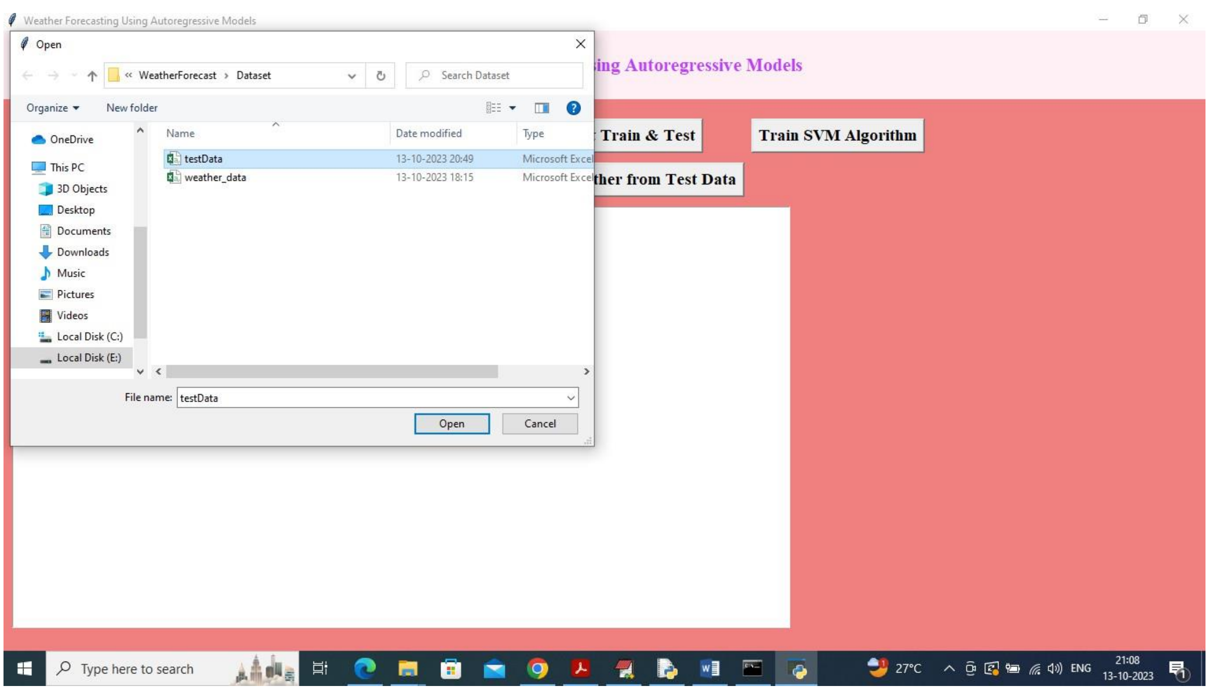
In above screen in first two lines we can see Autoregressive MSE and a MAE error value which are lower than SVM and can see predicted values also and below is the Autoregressive forecast graph



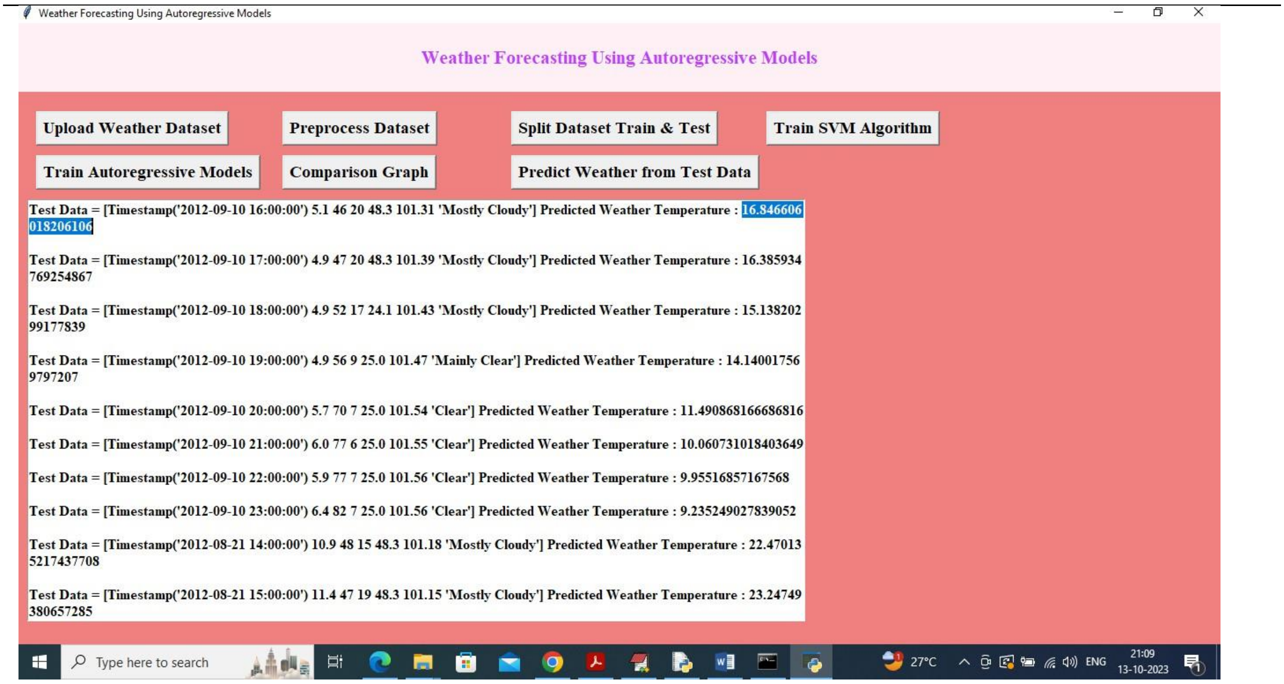
In above graph both original and Autoregressive forecast values are overlapping and we can say Autoregressive is accurate more than 99% as above graph is fully overlapping without gap and now close above graph and then click on 'Comparison Graph' button to get below graph



In above graph x-axis represents algorithm names and y-axis represents MSE and MAE values in different color bars and in both algorithms Autoregressive got less MSE and MAE error values so Autoregressive is best in prediction and now close above graph and then click on 'Predict Weather from Test Data' button to upload test data and predict weather temperature



In above screen selecting and uploading 'test data' and then click on 'Open' button to get below weather prediction



In above screen in square bracket we can see TEST data values and in last after: symbol we can see predicted weather temperature and based on temperature we can say

6. CONCLUSION AND FUTURE WORK

The exploration and application of Autoregressive Integrated Moving Average (ARIMA) models for weather forecasting present a promising alternative to traditional Numerical Weather Prediction (NWP) models. This research has demonstrated that ARIMA models, supported by their statistical foundations, can effectively utilize historical weather data to produce accurate short-term forecasts. The computational efficiency of these models is a significant advantage, making them accessible and practical for deployment in various settings, including those with limited resources.

One of the key findings of this study is the ability of ARIMA models to provide reliable forecasts while requiring significantly less computational power and observational data compared to NWP models. This efficiency enables faster processing times and reduces the dependency on extensive data collection infrastructures, which is particularly beneficial in remote or under developed regions. By harnessing historical data and identifying patterns and trends, ARIMA models offer a streamlined approach to weather forecasting that can be easily scaled and adapted to different climatic conditions and geographical locations.

7. REFRENCES

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