Multivariate time series analysis on the basis of temperature of Karnataka

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***Abstract*— This study involves a multivariate time series analysis mainly based on temperature data from Karnataka, India. Using advanced statistical machine learning techniques, we examine the temporal trends, seasonal trends, and potential relationships in the temperature dataset Our findings reveal small-scale temperature variations in Karnataka, and provide insights which is valuable for meteorological studies and local climate change assessments. This review highlights the importance of temperature-focused research in understanding local climate change and identifies targeted strategies for climate resilience and adaptation in Karnataka. Arima model to be selected for best possible outcomes.**

***Keywords*— Temperature analysis, temperature dynamics, temporal trends in temperature, temperature patterns, temperature fluctuations, temperature data analysis**

I. Introduction

An analysis of temperature trends is essential for understanding climate variability, regional manifestations and dynamics, as well as the implications of climate change. Karnataka, a state in the southern part of India, experiences various climate patterns as a result of its geographical location, seasonal monsoons, and human-induced factors. Therefore, the current research intends to present a multivariate time series analysis of the temperature while only focusing on the available data from Karnataka to uncover trends, variation, regularity, and relationships within this meteorological variable, as it is crucial to all of the other variables. Temperature is an essential indicator of climate change and variation, as it may display long-term trends, seasonal patterns, and short-term fluctuations. Therefore, it is possible to determine temporal patterns and seasonality and likely correlations within the datasets.

For a climate researcher, policymaker, and stakeholder, it is important to know all the above patterns in order to develop an appropriate climate adaptive and a betterment strategy suitable to the climate challenged region. The analysis of the multivariate time series by its dynamics allows us not only to see the general trend of temperature but also to assess the dependence of the temperature process on other meteorological parameters. Nevertheless, in this paper, we studied this pattern only within the bounds of one variable, as the most crucial and decisive, namely the air temperature. This work gives an idea of the dynamics of the temperature process, which helps to know the variability of the climate in the Karnataka region, which in turn will help the people and the government adapt and a better the measures appropriate for the climatic region.

II. TECHNIQUES USED FOR COMPUTATION

In our research on multivariate time series analysis focused on the temperature data of Karnataka for climate analysis, we have used various regression and forecasting models including Linear Regression, Lasso Regression, Ridge Regression, ANN, ensemble learning and ARIMA. We were aimed at determining out the most precise model for forecasting the temperature variations. Following the experiment and calculation, we discovered that the ARIMA model always gave superior results to the rest of the models. It delivered the most beneficial outcomes including temperature predictions varying between 25 and 27 which was quite close to the actual climate data.

Due to the quality of ARIMA model to fit the both linear and non-linear trends in temperature data, it is the most suitable for depicting the complex temporal patterns. This is even more critical in climate analysis where small variations and long-term trends are crucial for meticulous understanding of climate dynamics.

While the ANN ensemble learning method has the potential to capture very complex patterns, it was unable to deliver accurate temperatures forecasts in our case. The wide range of forecast from -15.0 to 15.3 shows that it does not have enough precision and reliability in predicting the actual temperature trend.

On a related note, we saw that Lasso Regression and Ridge Regression may not provide better performance than Linear Regression in some cases. Their performance resembles Linear Regression which suggest minimal gain in capturing the non-linear temperature changes in our data set.

III. TABLES, GRAPHS AND FIGURES

The image displays a table with two columns titled "Min Temperature" and "Max Temperature." There are 17 rows of data, each labeled with an index number from 0 to 16 on the left side. Each row shows a pair of temperatures, likely in degrees Celsius, with the minimum temperatures listed in the first column and the maximum temperatures listed in the second column. The temperatures vary across the rows, with minimum temperatures ranging from 0.0 to 16.0 and maximum temperatures ranging from 24.42 to 30.99.

	Min Temperature	Max Temperature
0	5.0	24.56
1	4.0	26.85
2	8.0	29.37
3	1.0	30.99
4	9.0	30.51
5	7.0	28.29
6	6.0	26.22
7	2.0	25.99
8	14.0	26.38
9	12.0	26.66
10	11.0	25.45
11	3.0	24.42
12	0.0	26.67
13	16.0	25.53
14	15.0	30.12
15	10.0	26.43
16	13.0	25.43

TABLE 1 : MINIMUM VS MAXIMUM TEMPERATURES IN KARNATAKA

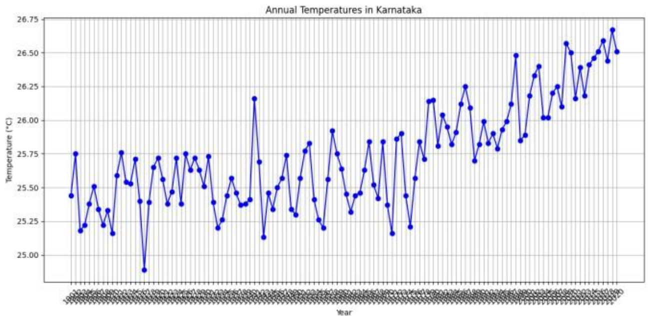

FIGURE 1:Annual temperatures in karnataka including summer, winter, monsoon and post monsoon

In the above figure 1, it shows that Karnataka experiences a diverse range of annual temperatures due to its varied geography and climatic zones. Coastal regions, like Mangalore, have relatively stable temperatures, with average highs around 20-25°C in summer and lows of 15-20°C in winter. Inland areas such as Bangalore exhibit a more moderate climate, with summer highs reaching 25-30°C and winter lows dropping to 15-20°C. Overall, Karnataka's annual temperatures reflect a mix of coastal, plateau, and semi-arid climatic influences.

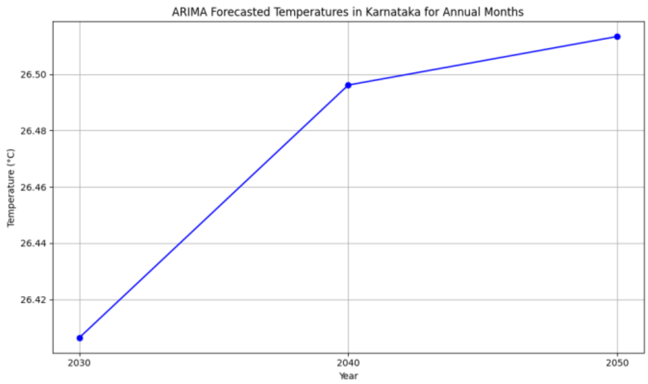

FIGURE 2 : ARIMA model representation for variation in temperature annually including summer, winter, monsoon and post-monsoon seasons

To map out yearly temperatures with an ARIMA (AutoRegressive Integrated Moving Average) model, we first got past year temperature records for Karnataka from trusted spots like weather offices or climate sites. After fixing up the data by dealing with missing bits and making sure it was all set to look at, we drew up a chart to show yearly temperature changes over time, spotting any up or down trends or clear patterns.

After that, we checked if our time series data didn't change too much over time, looking at things like the average, spread, and how the data points relate to each other over delays.

We then used simple math tools like looking at how data points match up over delays and how they do so when ignoring some in between, to pick the right ARIMA model bits. These bits tell us about the past effect, how many steps back we need to fix trends, and the smoothing out of random jumps. With these bits picked out, we fit our chosen ARIMA model to the yearly temperature records.

To see if the model did well, we had to check the leftover errors to make sure it fits well and guesses right. Using the ARIMA model we set up, we then made guesses about future yearly temperatures for Karnataka from what we knew and assumed in our model.

Putting the year's real temperatures, model fits, and future temps on a chart let us check how well the ARIMA model did and what it thinks will happen next. We then figured out what the ARIMA model's outcomes and temperature guesses mean for Karnataka's weather patterns, changes, and what could happen because of these trends.

The above graph results also include the data for all four divided parts of seasons which are summer, winter, monsoon and post monsoon respectively and the graphs represent the average of all the seasons temperature in the scale.

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