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Medium Range Forecast of Maximum Temperature of Coimbatore Using ARIMA

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ABSTRACT

Weather forecast is considered as one of the important forecasts which can protect life and property of future generation. It is the process of predicting the future conditions of climate and atmosphere with the help of statistical models and techniques, which is necessary to protect the agricultural production from unexpected environmental disasters. In the present study a time series analysis, ARIMA model is used to predict the future trend of weather parameters. Therefore, daily weather data of Coimbatore has been taken over the period of years from 1991 until 2017 to fit the ARIMA model using R software 3.5.2. The fitted ARIMA model is also validated using the statistical measure Akaike Information Criteria (AIC). As a result, this article yields the best fitted ARIMA model for maximum air temperature as ARIMA (3,0,1) of Coimbatore. These models are used to forecast the daily weather of Coimbatore with greater efficiency.

Keywords: ARIMA,Autocorrelation plot, Partial autocorrelation.

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INTRODUCTION

Agricultural farming is primarily based on weather condition. Weekly weather may influence the crop production, incidence of pests, water and fertilizer management, intercrop farm operation and all other farming activities performed during the growing season. Rainfall forecast is useful in predicting severe events that can lead to crop failure (*Pasaribu* et al.2018). Global climate change impacts the air temperature, relative humidity, duration of solar radiation, wind speed and rainfall. Area of irregular rainfall would require irrigation measures (Nikita et al. 2019). The consumer group has long been seeking detailed weather forecast at district level in the short or medium time scale (Adebiyi et al. 2014).

Climate cannot be controlled for crop growth but adapting with the prior knowledge of aberrant climate will mitigates its effect. Medium range weather forecast contributes to accurate impact assessment (Akrami et al. 2014). The local Agro met Advisory Committee is recommending agricultural operations

to the farmers of the area for the next three days on the basis of forecasted weather (Kumar et al. 2019). Environmental instability impacts on rice production system. It also provides some adaption measures for climate variability in order to minimize the risk (Valipour 2015).

The time series approach of autoregressive integrated moving average model is used to predict the future events that rely on past data (Rizkya et al. 2019). Box and jenkinsor ARIMA models are one of the dynamic approach used in many data pattern and it was successfully applied to resolve the predictive issues (Almasarweh and Wadi 2018). The data mining technique of ARIMA was implemented to predict the future climate data (Choudhury and Estefania 2020). ARIMA can be used to evaluate seasonal, even cyclic in time series data and to forecast the future rainfall (Kim et al. 2019).

MATERIALS AND METHODS

In time series analysis, daily weather data was analysed using ARIMA or box Jenkins methods. ARIMA is a mathematical modelling that is used to predict the future events based on input time series data given. Autoregressive integrated moving average (ARIMA) is denoted as (p, d, q), p-order of autoregressive, d-order of differencing, q- order of moving average. The steps to adopt the ARIMA modelling are as follows.

Model identification

Before to identify the model, to check the stationarity of the data by using the autocorrelation and unit root test. In this plot, the ACF value and PACF values are plotted for lags, the values begin to degrade rapidly to zero for stationary time series. Unit root test is non parametric ducky fuller test was developed to test the null hypothesis that in an autoregressive model of a given time series a unit root is present and the process is thus non stationary.

Estimation

After the order of the model was identified, then need to estimate the model parameter. Maximum likelihood estimation is used to estimate the parameter of ARIMA model in R. This method identifies the parameter values which optimize the probability of obtaining data that we have observed.

Diagnostic checking

Among the different models, the diagnostic check is used to evaluate if the residual of the configured ARIMA model fulfilled the underlying assumption. ACF residual plot and Ljung box test can have the value if the model parameter is accurately calculated at the prediction point using the maximum likelihood method. In this Ljung box test, the obtained p value

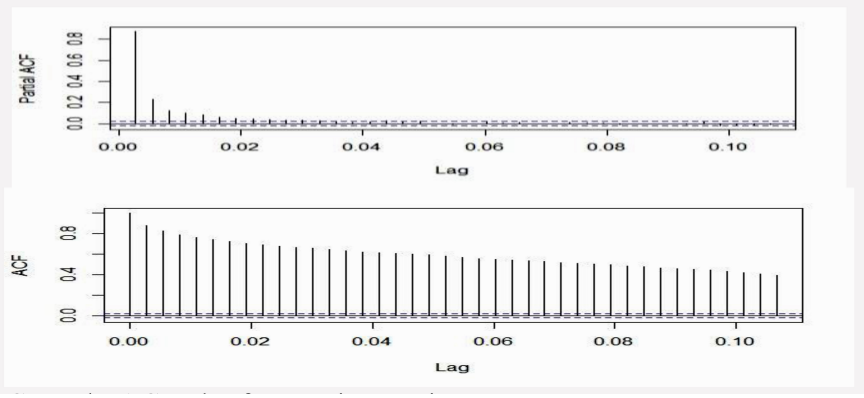

Figure 1. ACF and PACF plot for Maximum air temperature.

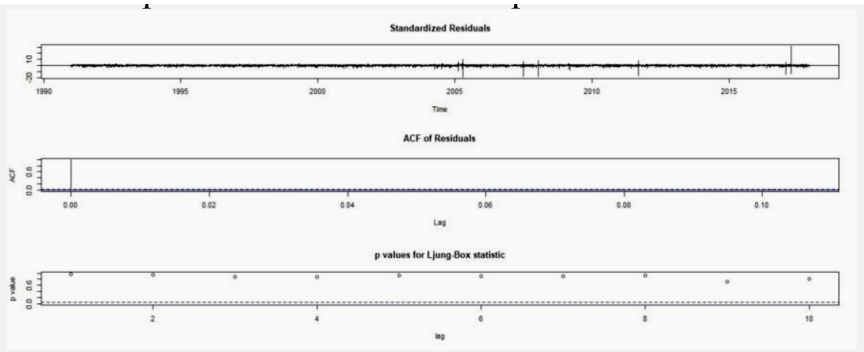

Figure 2. Plot of white noise test for maximum air temperature.

is greater than 0.05, to accept the null hypothesis is white noise of residual.

Forecasting

According to diagnostic check, best ARIMA model is identified and to fit the model to predict the future events based on the past values.

RESULTS AND DISCUSSION

Data collection

Daily weather data used in this study covers the periods from 1st January 1991 to 10th December 2017 of Coimbatore with 9841 observations. Data was obtained from agro climatic research centre of Tamil Nadu agricultural university, Coimbatore. First 9831 observations are taken as train datasets and last ten observations are taken as test datasets. The train datasets are used to fit the ARIMA model using R studio.

Model identification

Stationary test: ARIMA model fitted if the variable is stationary. Here, the stationary towards its mean and variance can be tested through Augmented Dickey fuller test (ADF) and Phillips- Perron Unit Root Test (PP) for hypothesis is stationary. From the Table 1 shows that the p-value obtained is less than 0.05 and null hypothesis is rejected. Therefore, the data is stationary. Then, several ARIMA models could be established for this datasets based on various values of p, d, q.

Table. 1. Stationary test results for weather parameter. * p-value in parentheses

Parameter	Adf test	PP test
Max. temperature	-8.53 (0.01)	-1070.3(0.01)

Identification of parameter

If the data is stationary, data able to be defined in order to achieve the ARIMA model prediction (p, d, q) . These values are identified by ACF and PACF plots. Fig. 1 shows ACF and PACF plot for air temperature, it is possible to show the exponential decay, and also it can be shown the lag value is small. Therefore, suggested autoregressive order p is 1,2,3 and moving average order q is 1, 2, 3.

Prediction of ARIMA model

There are 9 models are determined on the basis of ACF and PACF plots. They areon Table 2.

Table 2. ARIMA model prediction.

Model	MA (1)	MA(2)	MA(3)
AR(1)	ARIMA (1,0,1)	ARIMA(1,0,2)	ARIMA(1,0,3)
AR(2)	ARIMA(2,0,1)	ARIMA(2,0,2)	ARIMA(2,0,3)
AR(3)	ARIMA(3,0,1)	ARIMA(3,0,2)	ARIMA(3,0,3)

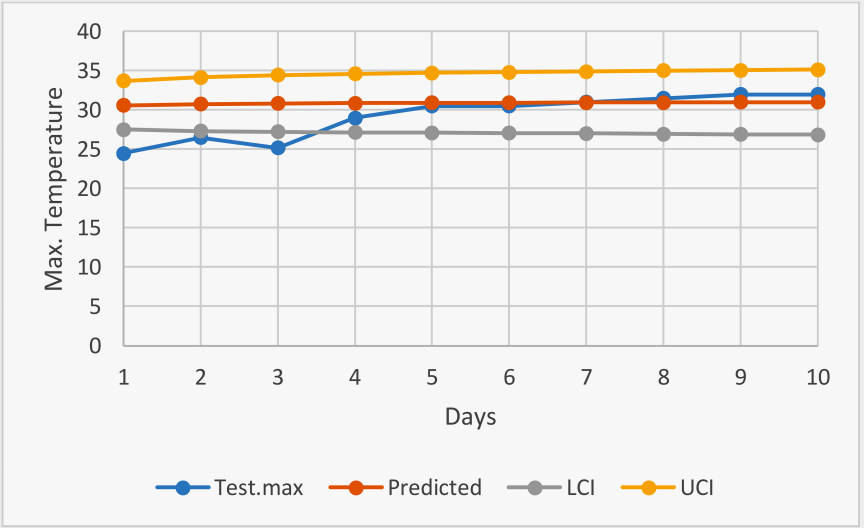

Figure 3. Prediction of Maximum air temperature.

Parameter estimation

To find out the parameter estimation for models. Estimated results are given below on Table 3. Based on the AIC criteria, the best fitted ARIMA model are selected. The model (3,0,1) has the lowest AIC value for Maximum Air temperature Based on the results given by Table 4, the obtained p value is less than 0.05, so reject the hypothesis and concluded that, estimated parameter of the ARIMA model (3,0,1) for air temperature is significant.

Diagnostic checking

The purpose of this study is to determine if the residual collected from the experiment is no auto-correlation. The result of Ljung test for residuals of ARIMA model.

The result of Fig. 3 shows the Ljung- Box test obtains p- value > 0.05, so accept the hypothesis. Therefore, it can be concluded that the model is white noise, meaning that ARIMA (3,0,1) meet the requirement and can be used for forecasting.

Forecasting

Since all ARIMA modelling measures have been carried out and the criteria of the ARIMA model have been fulfilled, then forecast the values using

Table 3. Results of estimated parameter of ARIMA (p, d, q) for Maximum air temperature.

Model	α_1	α_2	α_3	β_1	β_2	β_3	AIC
ARIMA (1,0,1)	0.96			-0.54			37087.48
ARIMA(1,0,2)	0.97			-0.51	-0.13		36957.32
ARIMA (1,0,3)	0.98			-0.51	-0.10	-0.07	36916.64
ARIMA (2,0,1)	1.24	-0.26		-0.77			36920.79
ARIMA (2,0,2)	1.52	-0.53		-1.06	0.19		36899.12
ARIMA (2,0,3)	1.53	-0.54		-1.06	0.19	0.00	36901.04
ARIMA (3,0,1)	1.28	-0.23	-0.06	-0.82			36901.18
ARIMA (3,0,2)	0.30	0.92	-0.25	0.18	-0.72		36922.38
ARIMA (3,0,3)	0.65	0.81	-0.47	-0.18	-0.75	0.17	36903.11

Table 4. The results of parameter significance test of ARIMA (3,0,1).

Parameter	Estimate	Std.Error	z value	Pr(>|z|)
α_1	1.284	0.018	70.344	2.20E-16
α_2	-0.233	0.017	-13.676	2.20E-16
α_3	-0.063	0.013	-4.738	2.16E-06
β_1	-0.819	0.015	-55.216	2.20E-16

the model. The predicted values are given in Table5. Fig. 3 shows the maximum air temperature using the ARIMA model (3,0,1) of Coimbatore district. Here, validate the predicted data with test datasets, this graph shows that predicted values are comes under the 90 % confidence interval.

CONCLUSION

From the research result, the best fitted ARIMA model for maximum air temperature of Coimbatore based on lowest value of AIC are ARIMA (3, 0, 1). This helps to forecast the daily weather of Coimbatore with greater efficiency.

Table 5. Result of predicted maximum air temperature.

Point	Predicted	LCI	UCI
D_1	30.61	27.51	33.71
D_2	30.74	27.33	34.16
D_3	30.84	27.24	34.43
D_4	30.88	27.17	34.60
D_5	30.92	27.11	34.72
D_6	30.94	27.06	34.82
D_7	30.96	27.01	34.91
D_8	30.98	26.96	35.00
D_9	31.00	26.92	35.08
D_{10}	31.01	26.88	35.15

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