Updated Moving Forecasting Model of Air Maximum Temperature

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Abstract. In the current study, a moving forecasting model is used for the purpose of forecasting maximum air temperature. A number of recordings are used for building the AR model and next, to forecasting some temperature values ahead. Then the AR model coefficients are updating due to shifting the training sample by adding new temperature values in order to involve the change in temperature time series behaviour. The current work shows a high performance all over the temperature time series, which considered in the analysis.

Keywords

Autoregressive Model; Baghdad City; prediction model; temperature.

1. Introduction

Global warming and the variability of climate are likely to cause a substantial problem for the ecosystem and go worst based on different scenarios of climate change (i.e., the temperature increased)[1, 2]. Massive emission of greenhouse gases resulting from natural disaster (e.g., volcanoes) or human activities (using fossil fuels) led to an increase in the influence of global warming [3, 4]. It has located a considerable impact on the environment of residential area in various places of the world [5-7]. These effects differ in terms of the region, the type, and the importance.

The climatic variables have affected, directly and indirectly, both individuals and their residential environment during various periods [8]. Temperature is the most vital climatic variables that impact the

growth, development and yield of crops [9]. Also, the dwellings' system is enhanced in response to climatic variables [10, 11].
Various countries face a harmful effect of global warming that led to reducing the quantity[12-16] and quality [17-22] of potable water resources. High temperatures (i.e., dry day) causes increase municipal water demand [23]. Also, various research revealed that municipal water demand was driven by maximum temperature [24-28].
Recently, precise prediction of temperature is a problem that has attracted the researchers' attention, since it has many various applications in the area such as industry, agriculture or energy. Different techniques and models are applied in several areas [29-33], and research forecast the maximum temperature by different techniques [34-36]. The AR model applied effectively in different applications [37-39]. In this research, Auto-regressive (AR) model will employ to forecast the monthly temperature.

2. Area of study and data set

Iraq is one of the Arab countries that lies in arid to the semi-arid area, and Baghdad is the capital of Iraq and locates in the centre of the country[40]. The weather is wet and cold in winter and dry and hot in summer (i.e., the temperature reaches 45 C). Iraq faced an acute climate change cased adversely impact the people, residential area, and freshwater sources[41-43]. The historical monthly data if maximum temperature along twelve years (2003-3014) used to build and assess the model.

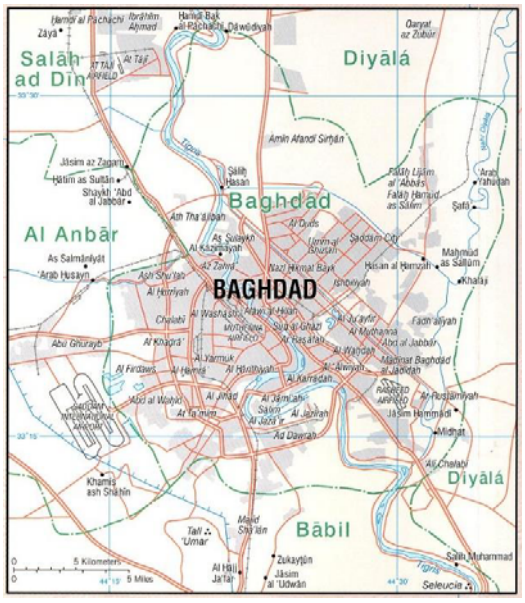

Figure 1. Location map of Baghdad city.

3. Methodology

The procedure of this research divides into, data pre-processing, and auto-regressive model.

3.1 Data Pre-processing

It has a considerable influence on the accuracy of the forecast techniques. It can be separated here into two phases: normalisation and cleaning. Normalisation time series assistances to decrease the impact of outliers and makes the data to be normal or near-normal distribution [44, 45]. In this research, a natural logarithm

is used for normalising the data due to its ability to decrease the influence of multicollinearity among predictor factors[28, 46].

3.2 Autoregressive Model (AR)

The autoregression model (AR) is a common approach to process and handle time series data to predict and forecast the variable of interest depending on past observations of the same variable at different stages [47]. This model receives a growing interest in different fields in which time series data are prevalent and the prediction of current and future values corresponding to a certain variable is needed. The valuable insights obtained from this model are the main cause of its popularity compared to other methods. Also, the solid inference of this model enables the city engineers and water authorities to overcome any shortage in drinking water provided to residents in a certain city.

To mathematically formulate autoregressive models, Eq. (1) is used to relate the current observation with the past ones in a linear relationship as illustrated [37, 38]:

$$X_t = \theta_0 + \sum_{i=1}^{p} k_i X_{t-1} + \varepsilon_t \quad (1)$$

Where; X_t and X_{t-1} are the observations in periods *t* and *t-1*, p is the order of the AR model considered, k_i is the autoregressive parameters, θ_0 is the constant term, and ε_t is the disturbance term for period *t.* A least-square algorithm using MATLAB is utilized to accurately predict the unknown coefficients in the AR model.

4. Results and discussion

Firstly, the time series data of maximum temperature are normalised and cleaned. The data then splitted into training set (70%) and testing set (30%). The AR model fitness metrics, i.e., R, MAE, MSE, and RMSE are shown in Figure 2A for the shifting steps. The overlapping of the new and old training sample is taken into consideration in order to avoid the adverse effect of the time series sudden change. The results reveal that the modelling process is quite accurate which makes the forecasting outputs are reliable. From the Figure 2B, it can be seen that the minimum R is 0.9 while the maximum MAR equals 1.5. The greatest MSE is no more than 0.4 and the RMSE equals 0.6 as a maximum.

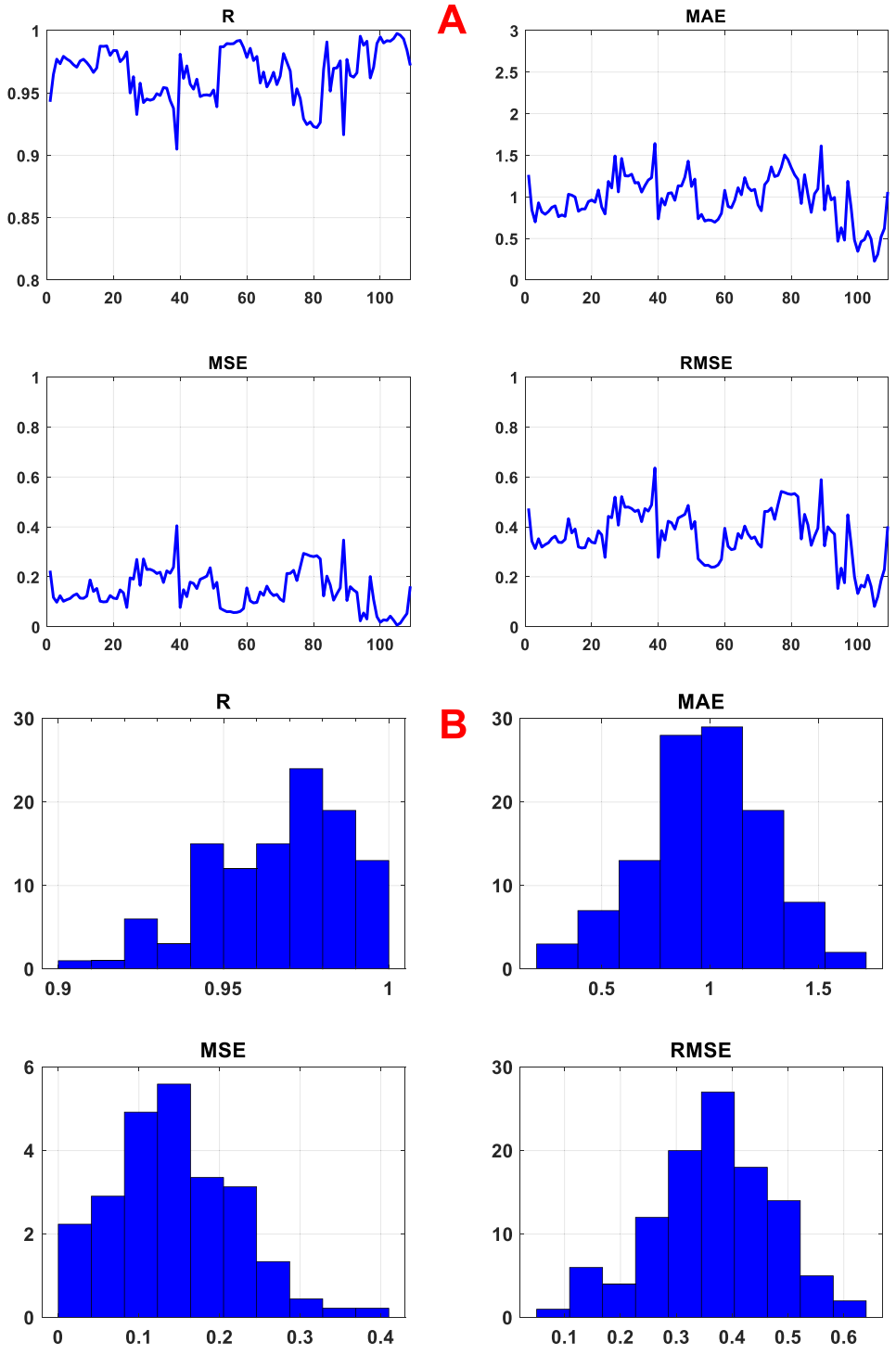

Figure 2. Four fitness metrics along many shifting of data to assess the AR model.

Figure 2 provides a comparable visualisation for measure and forecasted sample, which includes 16 monthly readings. The graph shows very similar values and trend which reflects a reliable forecasting performance.

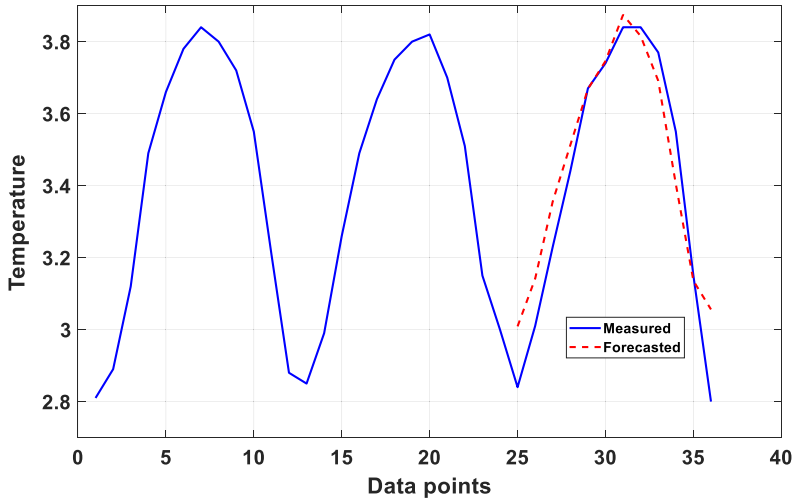

Figure 3. Measured and forecasted temperature.

From all the above tests, the AR model can simulate effectively the monthly maximum temperature along with different shifting of data.

5. Conclusions

Maximum temperature forecast is a significant component in active modern city planning and management due to it can help to find appropriate tools that used in building and industrials. In this study, data preprocessing and AR model used to forecast the monthly time series of temperature in Baghdad City over twelve years. the AR model coefficients are updating due to shifting the training sample by adding new temperature values in order to involving the change in temperature time series behaviour. The current works shows a high performance all over the temperature time series, which considered in the analysis (i.e., minimum R=0.9. Lastly, the suggest technique of this research can be applied as an early ground to base further research.

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