Updated Moving Forecasting Model of Air Maximum Temperature

To cite this article: Khalid Hashim et al 2021 IOP Conf. Ser.: Earth Environ. Sci. 877 012032

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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.

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

![Location map of Baghdad city.](image)
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]:

$$X_t = \theta_0 + \sum_{i=1}^{p} k_i X_{t-i} + \epsilon_t$$

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, $\theta_0$ is the constant term, and $\epsilon_t$ 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.

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.

6. References

[1] Zubaidi S L, Hashim K, Ethaib S, Al-Bdairi N S S, Al-Bugharbee H and Gharghan S K 2020 A novel methodology to predict monthly municipal water demand based on weather variables scenario Journal of King Saud University - Engineering Sciences 1-7

[2] Mohammed R and Scholz M 2019 Climate variability impact on the spatiotemporal characteristics of drought and Aridity in arid and semi-arid regions Water Resources Management 33 5015-33
Salman S A, Shahid S, Ismail T, Ahmed K and Wang X-J 2018 Selection of climate models for projection of spatiotemporal changes in temperature of Iraq with uncertainties *Atmospheric Research* **213** 509-22

Zubaidi S L, Abdulkareem I H, Hashim K, Al-Bugharbee H, Ridha H M, Gharghan S K, Al-Qaim F F, Muradov M, Kot P and Al-Khaddar R 2020 Hybridised Artificial Neural Network Model with Slime Mould Algorithm: A Novel Methodology for Prediction of Urban Stochastic Water Demand *Water* **12** 1-18

Jasim I A, Farhan S L, Al-Maliki L A and AL-Mamoori S K 2021 Climatic Treatments for Housing in the Traditional Holy Cities: A Comparison between Najaf and Yazd Cities. In: *IOP Conference Series: Earth and Environmental Science* (Najaf, Iraq: Materials Science and Engineering. IOP) pp 1-9

Farhan S L and Nasar Z A 2020 Urban identity in the holy cities of Iraq: Analysis of architectural design trends in the city of Karbala *Journal of Urban Regeneration and Renewal* **14** 210-22

Farhan S, Akef V, Antón D, Hashim K and Zubaidi S 2021 Factors influencing the transformation of Iraqi holy cities: the case of Al-Najaf *Przegląd Naukowy Inżynieria i Kształtowanie Środowiska* **30** 365-75

Zubaidi S L, Kot P, Hashim K, Alkhaddar R, Abdellatif M and Muhsin Y R 2019 Using LARS – WG model for prediction of temperature in Columbia City, USA. In: *IOP Conference Series: Materials Science and Engineering*, (Najaf, Iraq: Materials Science and Engineering. IOP) pp 1-9

Kadiyala M D, Nedumaran S, Singh P, S C, Irshad M A and Bantilan M C 2015 An integrated crop model and GIS decision support system for assisting agronomic decision making under climate change *Science of the Total Environment* **521-522** 123-34

Farhan S L, Jasim I A and Al-Mamoori S K 2019 The Transformation of The City of Najaf, Iraq: Analysis, Reality and Future Prospects *Journal of Urban Regeneration and Renewal* **13** 1-12

Farhan S, Akef V and Nasar Z 2020 The transformation of the inherited historical urban and architectural characteristics of Al-Najaf's Old City and possible preservation insights *Frontiers of Architectural Research* **1-17**

Mohammed R, Scholz M, Nanekely M, Mokhtari Y and assessment r 2018 Assessment of models predicting anthropogenic interventions and climate variability on surface runoff of the Lower Zab River *Stochastic Environmental Research and Risk Assessment* **32** 223-40

Mohammed R and Scholz M 2018 Flow–duration curve integration into digital filtering algorithms for simulating climate variability based on river baseflow *Hydrological Sciences Journal* **63** 1558-73

Hashim K S, Kot P, Zubaidi S L, Alwash R, Al Khaddar R, Shaw A, Al-Jumeily D and Aljefery M H 2020 Energy Efficient Electrocoagulation Using Baffle-Plates Electrodes for Efficient Escherichia Coli Removal from Wastewater *Journal of Water Process Engineering* **33** 1-7
[15] Hashim K S, Hussein A H, Zubaidi S L, Kot P, Kraidi L, Alkhaddar R, Shaw A and Alwash R 2019 Effect of Initial Ph Value on The Removal of Reactive Black Dye from Water by Electrocoagulation (EC) Method Journal of Physics: Conference Series 1294 1-6

[16] Ethaib S and Zubaidi S L 2020 Removal of Methylene Blue Dye from Aqueous Solution Using Kaolin. In: IOP Conference Series: Materials Science and Engineering, (Nasiriyah, Iraq: IOP) pp 1-7

[17] Al-Marri S, AlQuzweeni S S, Hashim K S, AlKhaddar R, Kot P, AlKizwini R S, Zubaidi S L and Al-Khafaji Z S 2020 Ultrasonic-Electrocoagulation method for nitrate removal from water. In: IOP Conference Series: Materials Science and Engineering, (Najaf, Iraq: IOP) pp 1-9

[18] Alnaimi H, Idan I J, Al-Janabi A, Hashim K S, Gkantou M, Zubaidi S L, Kot P and Muradov M 2020 Ultrasonic-electrochemical treatment for effluents of concrete plants. In: IOP Conference Series: Materials Science and Engineering, (Najaf, Iraq: IOP) pp 1-10

[19] Alyafei A, AlKizwini R S, Hashim K S, Yeboah D, Gkantou M, Al Khaddar R, Al-Faluji D and Zubaidi S L 2020 Treatment of effluents of construction industry using a combined filtration-electrocoagulation method. In: IOP Conference Series: Materials Science and Engineering, (Najaf, Iraq: IOP) pp 1-8

[20] Ethaib S, Omar R, Kamal S M M, Awang Biak D R and Zubaidi S L 2020 Microwave-Assisted Pyrolysis of Biomass Waste: A Mini Review Processes 8

[21] Ethaib S, Omar R, Kamal S M M, Awang Biak D R and Zubaidi S L 2020 Toward Sustainable Processes of Pretreatment Technologies of Lignocellulosic Biomass for Enzymatic Production of Biofuels and Chemicals: A Review BioResources 15 10063-88

[22] Hashim K S, Ewadh H M, Muhsin A A, Zubaidi S L, Kot P, Muradov M, Aljefery M and Al-Khaddar R 2020 Phosphate removal from water using bottom ash: Adsorption performance, coexisting anions and modelling studies Water Science and Technology 3 1-17

[23] Zubaidi S L, Ortega-Martorell S, Kot P, Alkhaddar R M, Abdellatif M, Gharghan S K, Ahmed M S and Hashim K 2020 A Method for Predicting Long-Term Municipal Water Demands Under Climate Change Water Resources Management 34 1265-79

[24] Adamowski J, Fung Chan H, Prasher S O, Ozga-Zielinski B and Sliusarieva A 2012 Comparison of multiple linear and nonlinear regression, autoregressive integrated moving average, artificial neural network, and wavelet artificial neural network methods for urban water demand forecasting in Montreal, Canada Water Resources Research 48 1-14

[25] Zubaidi S L, Dooley J, Alkhaddar R M, Abdellatif M, Al-Bugharbee H and Ortega-Martorell S 2018 A Novel approach for predicting monthly water demand by combining singular spectrum analysis with neural networks Journal of Hydrology 561 136-45

[26] Zubaidi S L, Gharghan S K, Dooley J, Alkhaddar R M and Abdellatif M 2018 Short-Term Urban Water Demand Prediction Considering Weather Factors Water Resources Management 32 4527-42
[27] Rasifaghihi N, Li S S and Haghighat F 2020 Forecast of urban water consumption under the impact of climate change *Sustainable Cities and Society* **52**

[28] Zubaidi S L, Ortega-Martorell S, Al-Bugharbee H, Olier I, Hashim K S, Gharghan S K, Kot P and Alkhaddar R M 2020 Urban Water Demand Prediction for a City That Suffers from Climate Change and Population Growth: Gauteng Province Case Study *Water* **12** 1-17

[29] Aljaaf A J, Van Tonder L, Mallucci C, Al-Jumeily D, Hussain A and Alloghani M 2019 Patients Attitude to Technology *Journal of medical systems* **43** 1-7

[30] Aljaaf A J, Mohsin T M, Al-Jumeily D and Alloghani M 2021 A fusion of data science and feed-forward neural network-based modelling of COVID-19 outbreak forecasting in IRAQ *Journal of Biomedical Informatics* **118** 1-8

[31] Al-Bugharbee H, Abolfathi A and Trendafilova I 2018 Vibration-Based Damage Detection of Structural Joints in Presence of Uncertainty *MATEC Web of Conferences* **148** 1-6

[32] Bugharbee H A and Trendafilova I 2018 A New Methodology for Fault Detection in Rolling Element Bearings Using Singular Spectrum Analysis *MATEC Web of Conferences* **148** 1-5

[33] Garcia D, Trendafilova I and Al-Bugharbee H 2014 Vibration-based health monitoring approach for composite structures using multivariate statistical analysis. In: EWSHM-7th European workshop on structural health monitoring. (France, Nantes: hal-01022019) pp 1743-50

[34] Cobaner M, Citakoglu H, Kisi O and Haktanir T 2014 Estimation of mean monthly air temperatures in Turkey *Computers and Electronics in Agriculture* **109** 71-9

[35] Appelhans T, Mwangomo E, Hardy D R, Hemp A and Nauss T 2015 Evaluating machine learning approaches for the interpolation of monthly air temperature at Mt. Kilimanjaro, Tanzania *Spatial Statistics* **14** 91-113

[36] Salcedo-Sanz S, Deo R C, Carro-Calvo L and Saavedra-Moreno B 2015 Monthly prediction of air temperature in Australia and New Zealand with machine learning algorithms *Theoretical and Applied Climatology* **125** 13-25

[37] Al-Bugharbee H and Trendafilova I 2015 Autoregressive Modelling for Rolling Element Bearing Fault Diagnosis *Journal of Physics: Conference Series* **628** 1-8

[38] Al-Bugharbee H and Trendafilova I 2016 A Fault Diagnosis Methodology for Rolling Element Bearings Based on Advanced Signal Pretreatment And Autoregressive Modelling *Journal of Sound and Vibration* **369** 246-65

[39] Zubaidi S L, Kot P, Alkhaddar R M, Abdellatif M and Al-Bugharbee H 2018 Short-Term Water Demand Prediction in Residential Complexes: Case Study in Columbia City, USA. In: 11th *International Conference on Developments in eSystems Engineering (DeSE)*. (Cambridge, United Kingdom: 11th International Conference on Developments in eSystems Engineering (DeSE). IEEE) pp 31-5
[40] Zubaidi S L, Al-Bugharbee H, Muhsen Y R, Hashim K, Alkhaddar R M and Hmeesh W H 2019 The Prediction of Municipal Water Demand in Iraq: A Case Study of Baghdad Governorate. In: 12th International Conference on Developments in eSystems Engineering (DeSE), (Kazan, Russia: 12th International Conference on Developments in eSystems Engineering (DeSE). IEEE) pp 274-7

[41] Farhan S L, Hashim I A J and Naji A A 2019 The Sustainable House: Comparative Analysis of Houses in Al Kut Neighborhoods-Iraq. In: 2019 12th International Conference on Developments in eSystems Engineering (DeSE), (Kazan, Russia: IEEE) pp 1031-6

[42] Al-Maliki L A, Farhan S L, Jasim I A, Al-Mamoori S K and Al-Ansari N 2021 Perceptions about water pollution among university students: A case study from Iraq Cogent Engineering 8 1895473

[43] Zubaidi S L, Al-Bugharbee H, Muhsin Y R, Hashim K and Alkhaddar R 2020 Forecasting of monthly stochastic signal of urban water demand: Baghdad as a case study. In: IOP Conference Series: Materials Science and Engineering, (Najaf, Iraq: IOP) pp 1-7

[44] Tabachnick B G and Fidell L S 2013 Using Multivariate Statistics vol sixth ed (United States of America: Pearson Education, Inc)

[45] Pallant J 2016 SPSS Survival Manual: A step by step guide to data analysis using IBM SPSS: Open University Press/McGraw-Hill

[46] Zubaidi S L, Al-Bugharbee H, Ortega-Martorell S, Gharghan S K, Olier I, Hashim K S, Al-Bdairi N S S and Kot P 2020 A Novel Methodology for Prediction Urban Water Demand by Wavelet Denoising and Adaptive Neuro-Fuzzy Inference System Approach Water 12 1-17

[47] Al-Bugharbee H and Trendafilova I 2014 Fault diagnosis in roller element bearings by using a linear autoregressive model. In: the 26th International Conference on Noise and Vibration Engineering, (Belgium, Leuven: Katholieke Universiteit Leuven) pp 2765-76