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Forecasting Covid-19 New Cases in Jordan

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***Abstract* - In this study, the ANN approach was applied to analyze COVID-19 new cases in Jordan. The employed data covers the period 1 January 2020 – 25 March 2021 and the out-of-sample period ranges over the period 26 March – 31 July 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is quite stable. The results of the study indicate that daily COVID-19 cases in Jordan are likely to significantly decline to zero cases per day around mid-May 2021. Amongst other suggested policy directions, there is need for the government of Jordan to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The COVID-19 pandemic was initially reported as a localized epidemic that was causing unexplained pneumonia cases in the city of Wuhan in China in late December 2019 and was later declared on the 11th of March 2020 as a global health threat by WHO (Phan, 2020; Yu et al, 2020; WHO, 2020; Wong et al, 2019). Several countries adopted recommendations by WHO which include social distancing, regular hand washing, contact tracing, quarantine or isolation, management of positive cases and health education (Ferguson et al, 2020; He et al, 2020). The COVID-19 pandemic has severely impacted the lives of people living in Jordan (UN, 2020). Essential services such as vaccinations, women's health, mental health and care of chronic medical conditions was substantially curtained (Jordan times, 2020). The country witnessed one of the worst economic down turns as reductions in tax revenues and remittances from workers from the Gulf countries (JD, 2019). Furthermore the pandemic increased the vulnerability of social groups like the elderly, migrant workers, refugees and people living with disability (UN, 2020).The purpose of this study is to model and predict daily COVID-19 cases in Jordan using the multilayer perceptron neural network. The artificial neural technique has gained prominence in forecasting COVID-19 cases & deaths and other health conditions (Maradze et al, 2021; Nyoni et al, 2021; Nyoni & Nyoni, 2021; Nyoni et al, 2020; Zhao, 2020). The findings of this study is expected to provide an insight of the likely future trends of COVID-19 in Jordan to facilitate decision making and allocation of resources towards prevention and control of COVID-19.

II. LITERATURE REVIEW

Rahimi et al (2020) did a systematic review and brief analysis of the most important machine learning forecasting models against COVID-19. A detailed scientometric analysis was performed as an influential tool for use in bibliometric analyses and reviews. The results of the study revealed that among the epidemic models, deep learning, SIR, and SEIR are the top models that were used by researchers. Hybrid algorithms are used to enhance the power of forecasting approaches and the majority of reviewed studies are deterministic approaches. Modeling and forecasting of COVID-19 using the hybrid dynamic model based on SEIRD and ARIMA was carried out by Ala'raj et al (2020).The study results showed that the hybrid model is very accurate in predicting infected, recovered, and deceased patients. Khalid et al (2020) simulated the trajectories of the COVID-19 pandemic curve in Jordan between February and May and assessed the effect of Jordan's strict NPI measures on the spread of COVID-19.The simulation model estimated the highest number of total daily new COVID-19 cases, in the pre-symptomatic compartmental state, to be 65 cases, with an epidemic curve growing to its peak in 49 days and terminating in a duration of 83 days, and a total simulated cumulative case count of 1048 cases. Motasem et al (2020)applied a mathematical model to estimate the R0 of COVID-19 in an outbreak occurring in both local and international clusters in light of published data. Different types of clusters (religious, wedding, and industrial activity) were selected based on reported events in different countries between February and April 2020. The findings of the study showed that the highest R0 values were found in wedding party events (5), followed by religious gathering events (2.5), while the lowest value was found in the industrial cluster (2).

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III. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modeling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting new COVID-19 cases Jordan.

Data Issues

This study is based on daily new cases of COVID-19 in Jordan for the period 1 January 2020 – 25 March 2021. The out-of-sample forecast covers the period 26 March 2021 – 31 July 2021. All the data employed in this research paper was gathered from the Johns Hopkins University (USA).

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	J
Observations	438 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.080004
MSE	183775.748729
MAE	257.776570

Residual Analysis for the Applied Model

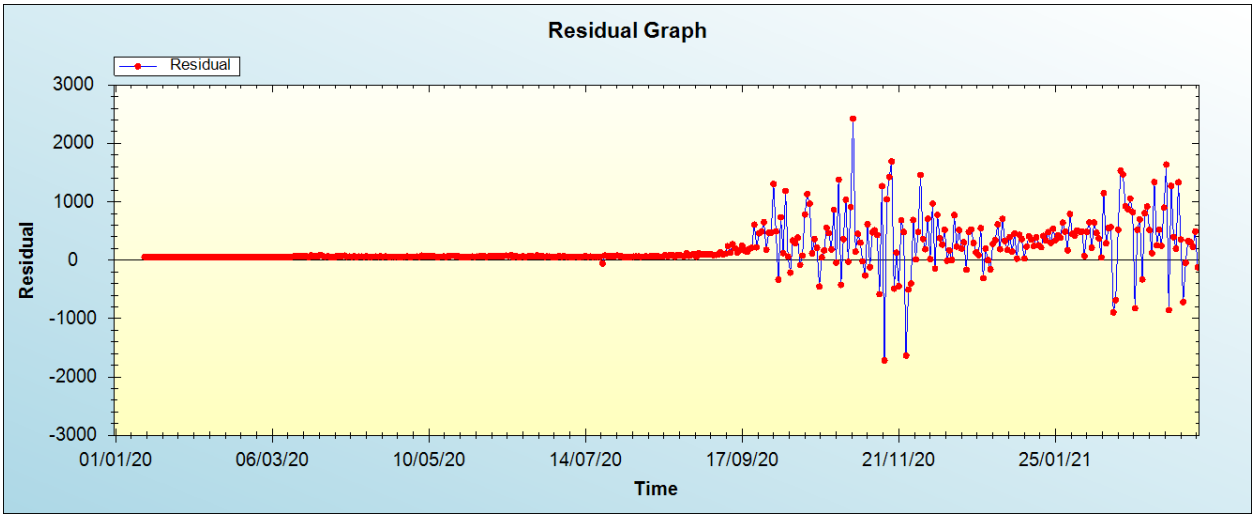

Figure 1: Residual analysis

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In-sample Forecast for J

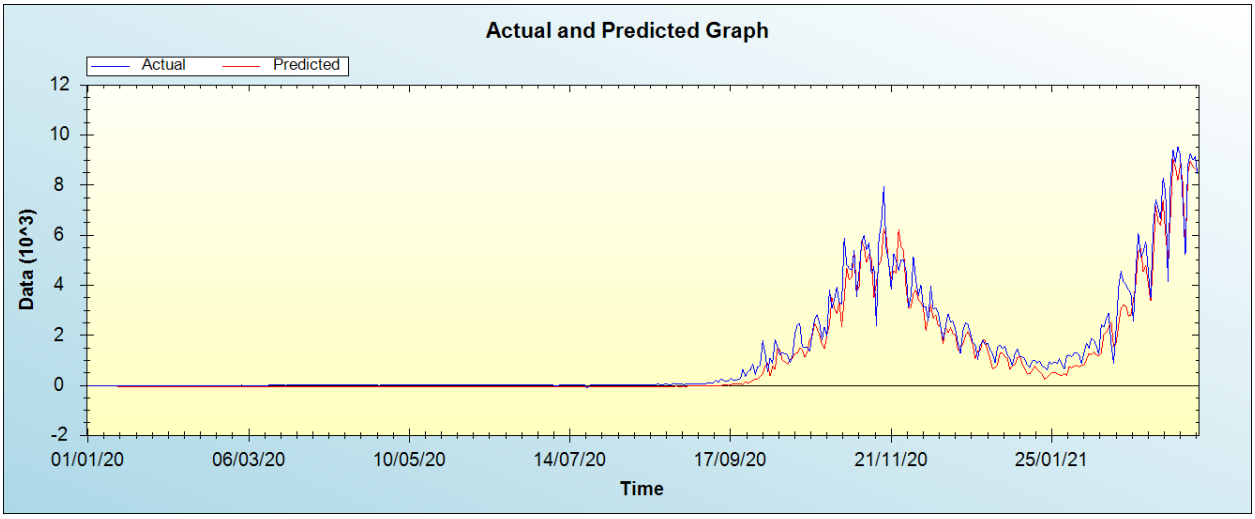

Figure 2: In-sample forecast for the J series

Out-of-Sample Forecast for J: Actual and Forecasted Graph

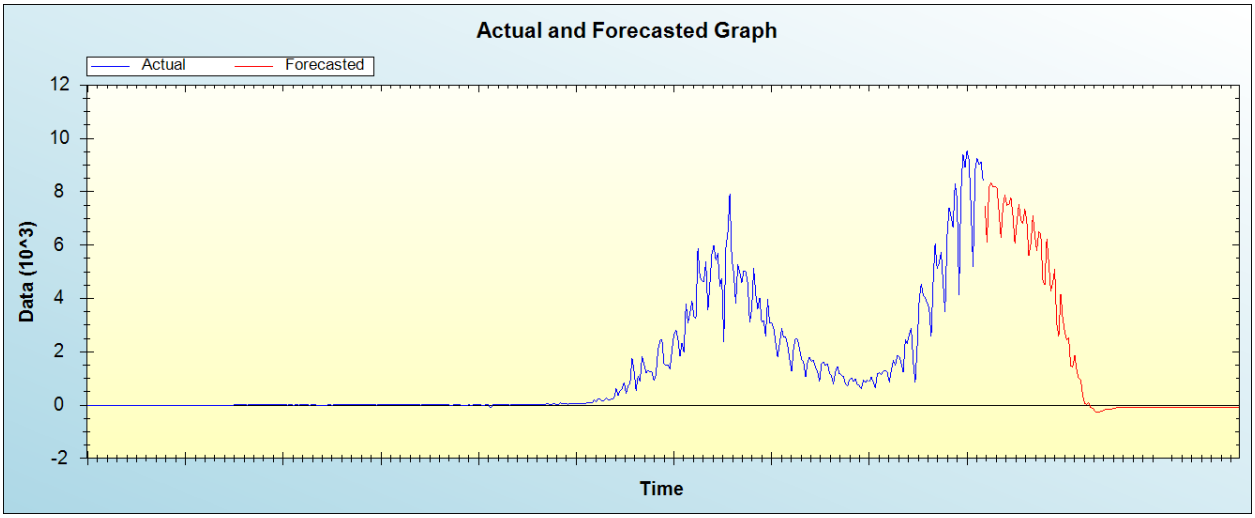

Figure 3: Out-of-sample forecast for J: actual and forecasted graph

Out-of-Sample Forecast for J: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	7455.9917
27/03/21	6097.1788
28/03/21	8147.4578
29/03/21	8351.8042
30/03/21	8171.8554
31/03/21	8186.7602
01/04/21	8148.4924
02/04/21	7269.2654
03/04/21	6283.0452
04/04/21	7435.9177
05/04/21	7881.3374
06/04/21	7489.4803
07/04/21	7530.8107
08/04/21	7774.4149
09/04/21	7115.2688

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10/04/21	6073.9574
11/04/21	6882.9214
12/04/21	7508.2666
13/04/21	6946.3777
14/04/21	6808.6839
15/04/21	7342.6864
16/04/21	6882.2916
17/04/21	5594.5509
18/04/21	6053.8348
19/04/21	7097.2860
20/04/21	6357.1914
21/04/21	5788.1724
22/04/21	6515.8201
23/04/21	6409.7495
24/04/21	4692.7135
25/04/21	4496.0283
26/04/21	6221.0307
27/04/21	5312.8983
28/04/21	4272.3057
29/04/21	4579.1501
30/04/21	5082.7110
01/05/21	3059.7071
02/05/21	2578.3710
03/05/21	4169.9077
04/05/21	3249.5302
05/05/21	2757.5573
06/05/21	2448.1432
07/05/21	2517.5276
08/05/21	1450.9283
09/05/21	1440.1149
10/05/21	1874.7641
11/05/21	1314.1317
12/05/21	1012.8154
13/05/21	956.0764
14/05/21	338.7109
15/05/21	60.5423
16/05/21	36.0252
17/05/21	89.5621
18/05/21	-96.7142
19/05/21	-113.1074
20/05/21	-203.7536
21/05/21	-280.1811
22/05/21	-277.0955
23/05/21	-236.8223
24/05/21	-219.5608
25/05/21	-166.6154
26/05/21	-150.8434
27/05/21	-151.0642
28/05/21	-153.3089
29/05/21	-131.4473
30/05/21	-114.8490
31/05/21	-91.6542
01/06/21	-75.4830
02/06/21	-70.1841
03/06/21	-74.8380
04/06/21	-75.7032
05/06/21	-77.2255
06/06/21	-73.8099
07/06/21	-69.9247
08/06/21	-67.7260
09/06/21	-70.9198
10/06/21	-74.7967
11/06/21	-78.9794
12/06/21	-81.0366

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13/06/21	-81.3507
14/06/21	-80.4106
15/06/21	-80.6344
16/06/21	-81.5783
17/06/21	-83.2848
18/06/21	-84.5871
19/06/21	-85.1483
20/06/21	-84.6617
21/06/21	-84.0258
22/06/21	-83.5678
23/06/21	-83.6197
24/06/21	-83.9017
25/06/21	-84.1867
26/06/21	-84.1089
27/06/21	-83.7936
28/06/21	-83.3858
29/06/21	-83.1427
30/06/21	-83.0967
01/07/21	-83.2150
02/07/21	-83.3100
03/07/21	-83.3118
04/07/21	-83.2060
05/07/21	-83.0872
06/07/21	-83.0191
07/07/21	-83.0448
08/07/21	-83.1180
09/07/21	-83.1881
10/07/21	-83.2094
11/07/21	-83.1900
12/07/21	-83.1549
13/07/21	-83.1415
14/07/21	-83.1572
15/07/21	-83.1917
16/07/21	-83.2199
17/07/21	-83.2293
18/07/21	-83.2191
19/07/21	-83.2037
20/07/21	-83.1952
21/07/21	-83.1990
22/07/21	-83.2093
23/07/21	-83.2182
24/07/21	-83.2191
25/07/21	-83.2133
26/07/21	-83.2053
27/07/21	-83.2009
28/07/21	-83.2014
29/07/21	-83.2050
30/07/21	-83.2080
31/07/21	-83.2082

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that daily COVID-19 cases in Jordan are likely to significantly decline to zero cases per day around mid-May 2021.

V. CONCLUSION AND POLICY RECOMMENDATIONS

The government of Jordan put in place a five-year economic growth plan for the period 2018-2022. The main thrust of the plan is to reduce socio-economic inequalities by promoting more access to social services, health insurance and education. The COVID-19 outbreak has severely impacted on the economic growth for Jordan, with anticipated new waves of infections, movement and business restrictions likely to aggravate challenges for individuals, households and the country. Therefore the authors decided to model and forecast daily COVID-19 cases in Jordan so that the authorities can understand the evolution of the epidemic and prepare adequate resources to curtail the spread of the virus. The results of the study show that daily COVID-19

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cases in Jordan are likely to significantly decline to zero cases per day around mid-May 2021. However, we still encourage adherence to prevention measures against the pandemic.

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