

Forecasting Covid-19 New Cases in New Zealand

¹Dr. Smartson. P. NYONI, ²Mr. Thabani NYONI, ³Mr. Tatenda. A. CHIHOHO

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²SAGIT Innovation Center, Harare, Zimbabwe

³Independent Health Economist, Harare, Zimbabwe

Abstract - In this study, the ANN approach was applied to analyze COVID-19 new cases in New Zealand. 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 New Zealand are generally likely to remain above 40 cases per day over the out-of-sample period. Amongst other suggested policy directions, there is need for the government of New Zealand to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic.

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

The whole world is currently experiencing the worst pandemic and the GDP has collapsed by at least 10 % in most countries affected by the novel corona virus (Ho et al, 2020). The economic challenges have been aggravated by government led lockdowns and mitigatory measures by households and businesses. At the end of December 2019, first cases of COVID-19 were reported in Wuhan, China and on the 7th of January 2020 the novel corona virus was genetically sequenced and linked to the respiratory disease COVID-19 (WHO, 2020). Many countries had to quickly respond to the fast spreading virus, mortalities and exponential growth by imposing lockdowns (Frank & Grady, 2020). This meant that people must stay at home, shut down businesses and work from home and thus avoiding physical contact (Sibley et al, 2020). The New Zealand imposed its first lockdown on the 23rd of March 2020. The government enforced adherence to WHO guidelines on prevention and control of COVID-19 such as social distancing, wearing face masks, hygiene practices, contact tracing, isolation and management of positive cases (Petherick et al, 2020; MOH, 2020). The lockdown imposed by the government was very effective in controlling the spread of the COVID-19 virus, daily new cases declined significantly (New Zealand, 2020). This revealed that non-pharmacological interventions depend on early decisive performant surveillance system and targeted testing strategies (Robert, 2020). The aim of this paper is to predict daily COVID-19 cases in New Zealand using the artificial neural network approach. This method has been demonstrated to very useful in forecasting infectious diseases and non-communicable medical conditions (Maradze et al, 2021; Nyoni et al, 2021; Nyoni & Nyoni, 2021; Nyoni et al, 2020; Zhao et al, 2020). The findings of this study are expected to provide an insight of the future trends of COVID-19 in the country, facilitate decision making and allocation of resources to curb the spread of the SARS-COV2 virus.

II. LITERATURE REVIEW

Ho et al (2020) forecasted COVID-19 cases and deaths in New Zealand using the Bayesian estimation. The authors chose functional forms for infections and deaths that incorporate important features of epidemiological models but allow for flexible parameterization to capture different trajectories of the pandemic. The Bayesian estimation revealed that the simple statistical framework they employed fitted the data well and allowed for a transparent characterization of the uncertainty surrounding the trajectories of infections and deaths. Attanayake & Perera (2020) modeled and predicted COVID-19 cases in eight countries: Italy, New Zealand, the USA, Brazil, India, Pakistan, Spain, and South Africa which are in different phases of COVID-19 distribution as well as in different socioeconomic and geographical characteristics were selected as test cases. The Alpha-Sutte Indicator approach was utilized as the modelling strategy. The study concluded that the Alpha-Sutte method can be recommended for short-term forecasting of cumulative COVID-19 incidences. Merow & Urban (2020) developed a model that explains 36% of the variation in maximum COVID-19 growth rates based on weather and demography (17%) and country-specific effects (19%). UV light is most strongly associated with lower COVID-19 growth. Projections suggest that, without intervention, COVID-19 will decrease temporarily during summer, rebound by autumn, and peak next winter. 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. A modified susceptible, exposed, infected, and recovered (SEIR) epidemic model was utilized. The compartments in the proposed model categorized the Jordanian population into six deterministic compartments: suspected, exposed, and infectious pre-symptomatic, infectious with mild symptoms, infectious with moderate to severe symptoms, and recovered. The GLEAMviz client simulator was used to run the simulation model. Epidemic curves were plotted for estimated COVID-19 cases in the simulation model, and compared against the reported cases. 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.

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 New Zealand.

Data Issues

This study is based on daily new cases of COVID-19 in New Zealand 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	NZ
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	0.084823
MSE	18.389238
MAE	2.937823

Residual Analysis for the Applied Model

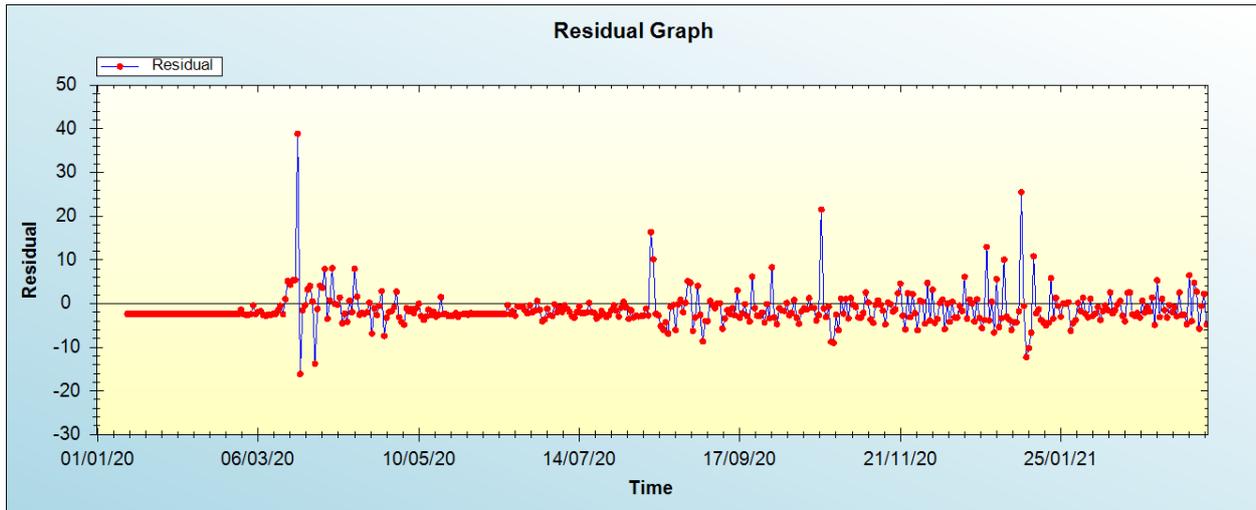


Figure 1: Residual analysis

In-sample Forecast for NZ

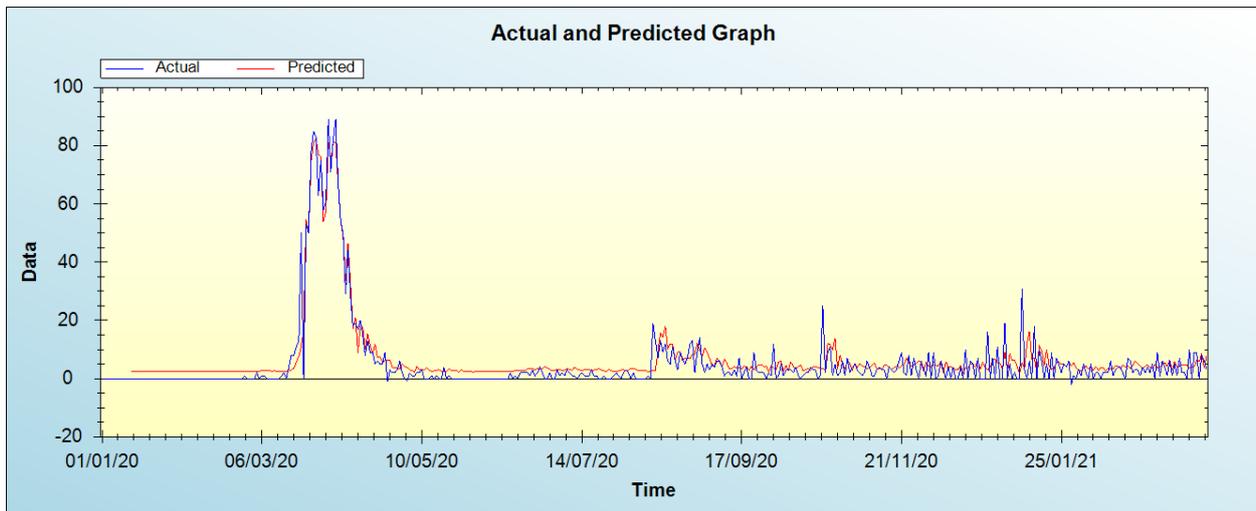


Figure 2: In-sample forecast for the NZ series

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

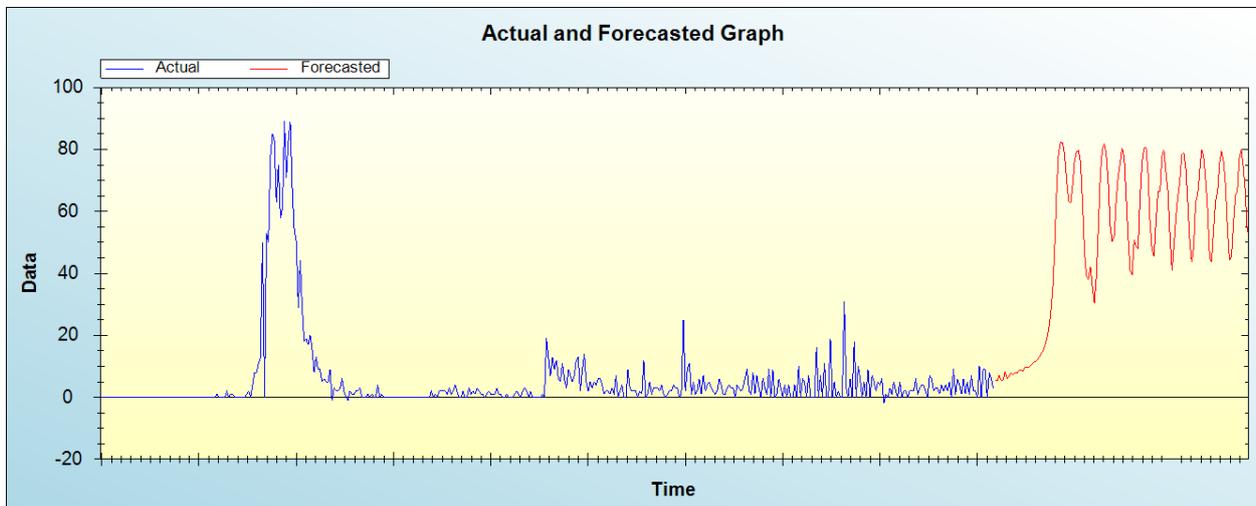


Figure 3: Out-of-sample forecast for NZ: actual and forecasted graph

Out-of-Sample Forecast for NZ: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Forecasts
26/03/21	5.6611
27/03/21	5.2957
28/03/21	7.2136
29/03/21	5.4858
30/03/21	5.5970
31/03/21	8.2935
01/04/21	5.9787
02/04/21	6.7261
03/04/21	7.9296
04/04/21	7.3328
05/04/21	7.8459
06/04/21	7.7954
07/04/21	8.6452
08/04/21	8.7351
09/04/21	8.4749
10/04/21	9.5845
11/04/21	9.6383
12/04/21	9.7863
13/04/21	10.5130
14/04/21	10.8714
15/04/21	11.5211
16/04/21	11.9653
17/04/21	12.8656
18/04/21	13.9342
19/04/21	14.8367
20/04/21	16.6589
21/04/21	18.7621
22/04/21	21.9341
23/04/21	27.0196
24/04/21	35.0225
25/04/21	48.9156
26/04/21	66.4547
27/04/21	78.8575
28/04/21	82.3362
29/04/21	82.0053
30/04/21	78.2721
01/05/21	69.9675
02/05/21	63.3287
03/05/21	62.6396
04/05/21	68.1602
05/05/21	75.9817
06/05/21	79.1757
07/05/21	79.6779
08/05/21	75.8552
09/05/21	62.6005
10/05/21	46.8106
11/05/21	39.4126
12/05/21	37.9791
13/05/21	42.1711
14/05/21	35.9900
15/05/21	30.4711
16/05/21	39.0644
17/05/21	54.7311
18/05/21	72.5432
19/05/21	80.0125
20/05/21	81.8669
21/05/21	78.7339
22/05/21	69.6950
23/05/21	55.2072

24/05/21	50.2550
25/05/21	52.1538
26/05/21	64.0602
27/05/21	71.4158
28/05/21	75.6291
29/05/21	80.4936
30/05/21	77.1433
31/05/21	64.7296
01/06/21	50.9706
02/06/21	40.9332
03/06/21	39.5799
04/06/21	50.6901
05/06/21	48.8850
06/06/21	47.9672
07/06/21	64.7905
08/06/21	76.3324
09/06/21	80.4271
10/06/21	80.8117
11/06/21	72.5131
12/06/21	56.4420
13/06/21	48.1322
14/06/21	45.5625
15/06/21	57.3316
16/06/21	66.3842
17/06/21	66.4848
18/06/21	77.8833
19/06/21	79.9214
20/06/21	72.8245
21/06/21	66.6368
22/06/21	52.3940
23/06/21	41.1359
24/06/21	48.7889
25/06/21	57.9709
26/06/21	64.9089
27/06/21	69.5468
28/06/21	78.2403
29/06/21	78.8581
30/06/21	74.0582
01/07/21	62.4607
02/07/21	49.9949
03/07/21	43.7031
04/07/21	48.5873
05/07/21	63.0947
06/07/21	65.3344
07/07/21	72.6844
08/07/21	79.9654
09/07/21	77.4791
10/07/21	70.1172
11/07/21	60.3038
12/07/21	45.2255
13/07/21	43.7740
14/07/21	53.8133
15/07/21	63.3930
16/07/21	66.1584
17/07/21	75.6094
18/07/21	79.5645
19/07/21	76.3003
20/07/21	68.9112
21/07/21	54.9915
22/07/21	44.3985
23/07/21	45.2003
24/07/21	55.8399
25/07/21	65.1135
26/07/21	66.5578

27/07/21	77.4177
28/07/21	79.7275
29/07/21	74.3408
30/07/21	66.6606
31/07/21	53.3389

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 New Zealand are generally likely to remain above 40 cases per day over the out-of-sample period.

V. CONCLUSION AND POLICY RECOMMENDATIONS

Public health surveillance involves collection, analysis, interpretation and dissemination of health data essential to prevention and control (Nobre et al, 2001). The aim of Public health surveillance systems is to facilitate the detection of abnormal behavior of infectious diseases and other health events. Different statistical methods have been applied to forecast infectious disease incidence. The time series models predict epidemiological behaviors by modeling historical surveillance data. Many researchers have applied different time series models to forecasting epidemic incidence in previous studies (Zhang et al, 2014). In this study we applied the ANN (12, 12, 1) model to predict daily COVID-19 cases in New Zealand. The results indicate that daily COVID-19 cases in New Zealand are generally likely to remain above 40 cases per day over the out-of-sample period. Therefore the government should scale up vaccination against COVID-19 including adherence to other public health mitigation measures.

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