PREDICTION OF COVID-19 CASES IN CHILE USING ARTIFICIAL NEURAL NETWORKS

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ABSTRACT

The crisis of COVID-19 is growing and has devastating implications for many countries around the world. In this research article, the ANN technique was applied to analyze daily COVID-19 cases in Chile based on a data set covering the period February 23, 2020 to October 31, 2020. The out-of-sample period ranges over the period November 2020 to April 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the employed model suggest that the model is stable in forecasting COVID-19 cases in Chile. The results of the study imply that daily COVID-19 cases will sharply decline, from the estimated 1096 cases on November 1, 2020; until around December 23, 2020; where an equilibrium daily case volume of approximately 153 cases may be reached and this daily equilibrium case volume is most likely to be persistant through out the rest of the out-of-sample period. Despite the projected further decrease in COVID-19 cases in Chile, the government of the country should continue to implement strong control and preventive measures in order to save lives.

Keywords: - *ANN, COVID-19, Forecasting*

INTRODUCTION

The outbreak of COVID-19 was first detected in Wuhan, China, in late 2019 (Porcheddu *et al*., 2020). Later on, the virus has overtaken the burden of morbidity and mortality around the world with a quick and dexterous spread compared to China (Jahan & Rahman, 2020). The clinical symptoms of COVID-19 are identified as fever, cough, rhinorrhea, sneezing, sore throat, and fatigue, while other symptoms include sputum production, headache, haemoptysis, diarrhoea, dyspnea, and lymphopenia (Carlos *et al*., 2020; Huang *et al*., 2020; CDC, 2020). In addition, there are abnormal features like acute respiratory distress syndrome and acute cardiac injury (Huang *et al*., 2020). The genomic sequence analysis of COVID-19 indicates that approximately 80% of transmission occurs primarily from person-to-person transmission through droplets of saliva or discharge from the nose when an infected person coughs or sneezes (Lu *et al*., 2020; Wan *et al*., 2020). In Chile, the first case was officially confirmed on February 23, 2020, in Talca (Baeza-Yates, 2020). Although other cases were rapidly confirmed all over the country, the capital city, Santiago, quickly became the epicenter of the pandemic. The first set of non-pharmaceutical interventions (NPIs) were put in place in mid-March, when schools were closed, public gatherings were banned, and passengers travelling from high-risk countries were

mandated to self-isolate for 14 days. Unfortunately, the adopted measures were not able to contain the virus, after a sharp increase in cases; a full lockdown was instituted (Government of Chile, 2020). Restricting the movement of people, reducing contact, disseminating key high-frequency prevention information through multiple channels, mobilizing state and local authorities to respond quickly to the contingency, can help contain the pandemic (WHO, 2020; Rothan & Byrareddy, 2020; Liu *et al*., 2020; Guo *et al*. 2020; Adhikari *et al*., 2020). In the case of Chile, a few studies have devoted towards modelling and or forecasting COVID-19, for instance, Diaz-Narvaez *et al*. (2020), Vergara-Hermosilla & Navas (2020) as well as Cancino *et al*. (2020). Based on a SEIR model, Cancino *et al*. (2020) concluded that there would be a shift in the peak of the pandemic in the country with a small reduction in the amplitude in the demand for hospital resources when the lockdown strategy is implemented. Using an extended SIRU model, Vergara-Hermosilla & Navas (2020) basically suggested that the pandemic would gradually disappear in the near future if the Chilean government continues to implement mitigation measures. Employing quadratic, exponential, simple exponential smoothing and double exponential smoothing models, Diaz-Narvaez *et al*. (2020) found out that the curve that best fits the evolution of the accumulated confirmed cases of COVID-19 in Chile is the double exponential smoothing model and also established that the number of infected patients will continue to increase. The main purpose of this research is to model and forecast daily confirmed COVID-19 cases in Chile.

METHODOLOGY

This paper applies the multi-layer perceptron neural network type of the ANN approach in order to predict daily new COVID-19 infections in Chile. This piece of work particularly applies the ANN (12, 12, 1) model and chooses the more efficient hyperbolic tangent function as the activation function. This study is apparently hinged on daily new Covid-19 cases (referred to as CC series in this study) for all age groups in Chile. The data covers the period 23 February 2020 to 31 October 2020 while the out-of-sample forecast covers the period November 2020 to April 2021. All the data employed in this paper was gathered from the COVID-19 data repository prepared by the CSSE at JH University.

FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
2024.8	1725.0	0.00000	13990.
Std. Dev.	C.V.	Skewness	Ex. kurtosis
1932.6	0.95444	2.4547	10.082
5% Perc.	95% Perc.	IQ range	Missing obs.
0.00000	5475.3	1909.8	0

ANN MODEL SUMMARY FOR COVID-19 DAILY CASES IN CHILE

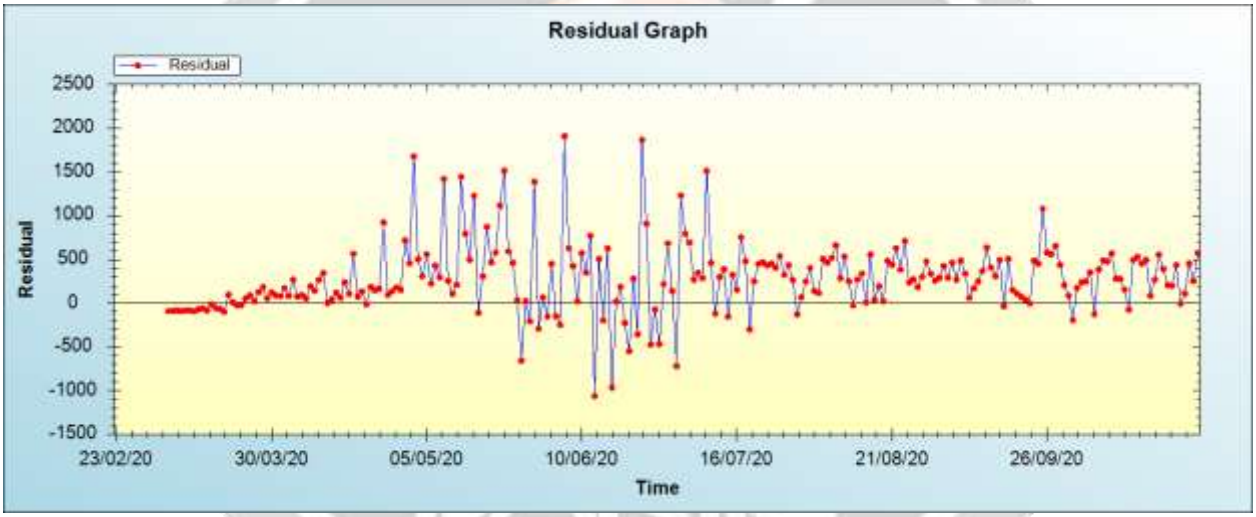
Table 2: ANN model summary

Variable	CC

Observations	240 (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	0.063264
MSE	241768.945762
MAE	360.128806

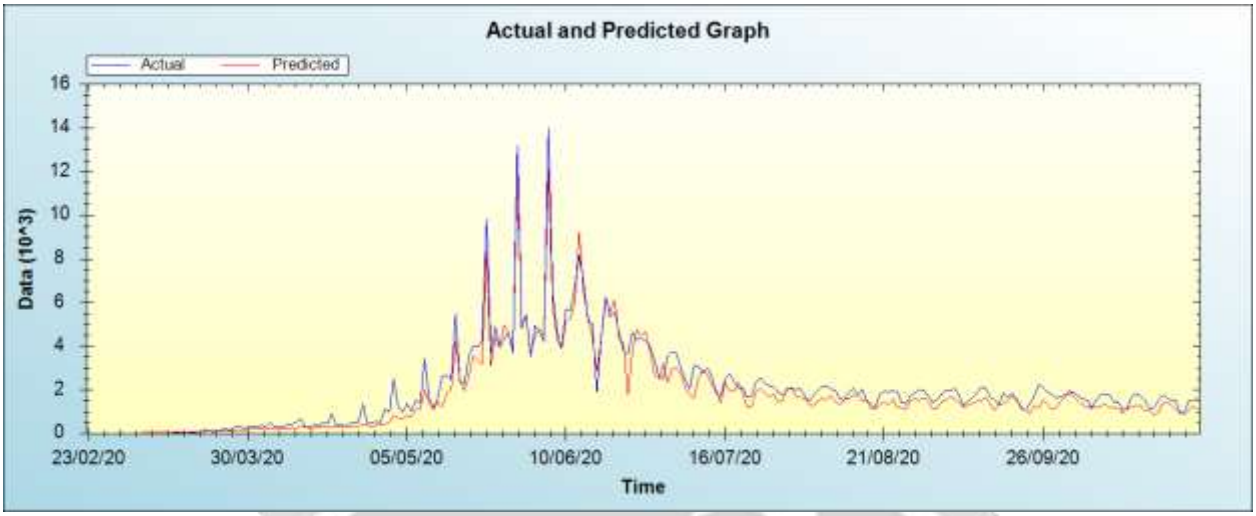
Residual Analysis for the ANN model

Figure 1: Residual analysis



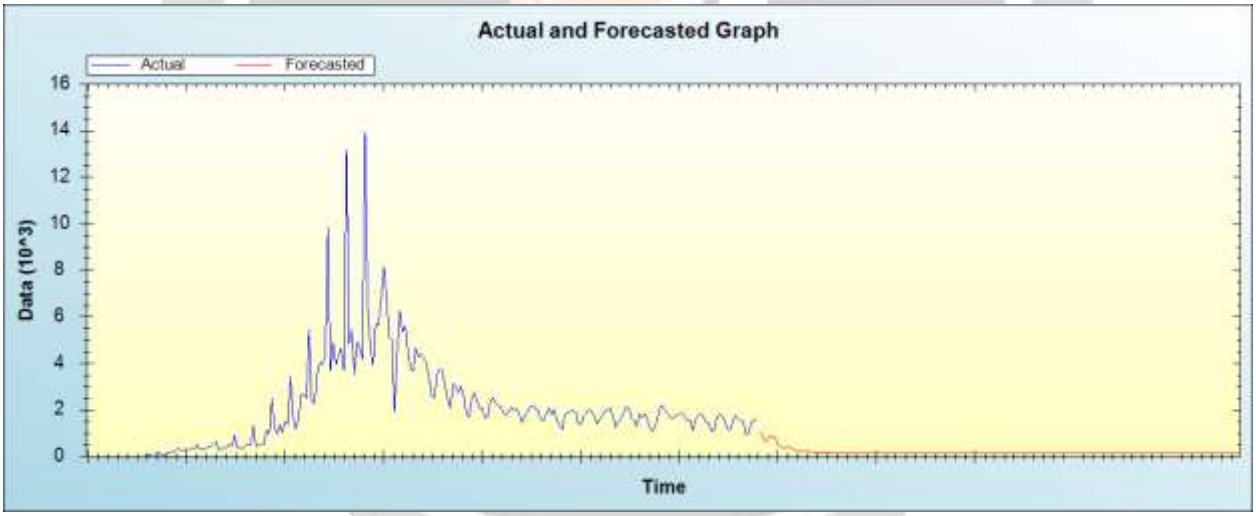
In-sample Forecast for CC

Figure 2: In-sample forecast for the CC series



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

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



Out-of-Sample Forecast for CC: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Day/Month/Year	Forecast
01/11/20	1095.8610
02/11/20	954.3899
03/11/20	669.8456
04/11/20	696.3922

05/11/20	918.7343
06/11/20	805.1430
07/11/20	828.3706
08/11/20	479.2719
09/11/20	419.6235
10/11/20	363.2190
11/11/20	360.7967
12/11/20	438.9157
13/11/20	354.5589
14/11/20	341.6141
15/11/20	228.7542
16/11/20	218.7509
17/11/20	223.1420
18/11/20	214.0720
19/11/20	240.1917
20/11/20	201.7074
21/11/20	194.2291
22/11/20	169.2206
23/11/20	168.0244
24/11/20	175.6636
25/11/20	169.4911
26/11/20	176.8381
27/11/20	163.3168
28/11/20	160.8898
29/11/20	157.3404
30/11/20	156.6898

01/12/20	160.4349
02/12/20	157.4905
03/12/20	159.1376
04/12/20	155.2214
05/12/20	154.5370
06/12/20	154.6989
07/12/20	154.1951
08/12/20	155.5691
09/12/20	154.4109
10/12/20	154.6681
11/12/20	153.7483
12/12/20	153.5374
13/12/20	153.9054
14/12/20	153.6287
15/12/20	154.0527
16/12/20	153.6619
17/12/20	153.6611
18/12/20	153.5115
19/12/20	153.4320
20/12/20	153.6130
21/12/20	153.4935
22/12/20	153.6053
23/12/20	153.4926
24/12/20	153.4694
25/12/20	153.4703
26/12/20	153.4370

27/12/20	153.5031
28/12/20	153.4598
29/12/20	153.4837
30/12/20	153.4572
31/12/20	153.4439
01/01/21	153.4577
02/01/21	153.4441
03/01/21	153.4645
04/01/21	153.4510
05/01/21	153.4542
06/01/21	153.4501
07/01/21	153.4444
08/01/21	153.4519
09/01/21	153.4468
10/01/21	153.4522
11/01/21	153.4487
12/01/21	153.4482
13/01/21	153.4485
14/01/21	153.4463
15/01/21	153.4492
16/01/21	153.4475
17/01/21	153.4487
18/01/21	153.4480
19/01/21	153.4474
20/01/21	153.4480
21/01/21	153.4472

22/01/21	153.4481
23/01/21	153.4476
24/01/21	153.4478
25/01/21	153.4478
26/01/21	153.4475
27/01/21	153.4478
28/01/21	153.4475
29/01/21	153.4478
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26/04/21	153.4476
27/04/21	153.4476
28/04/21	153.4476
29/04/21	153.4476
30/04/21	153.4476

The descriptive statistics, summary of the applied forecasting model, residual analysis, in-sample forecasts as well as out-of-sample forecasts are shown in table 1, table 2, figure 1, figure 2 and well as figure 3 and table 3, respectively. The results of the study indicate that daily COVID-19 cases will sharply decline, from the estimated 1096 cases on November 1, 2020; until around December 23, 2020; where an equilibrium daily case volume of approximately 153 cases will be reached and this daily equilibrium case volume is likely to be persistant through out the rest of the out-of-sample period. While the total number of infected patients will continue to increase (Diaz-Narvaez *et al*., 2020), our study, in line with Vergara-Hermosilla & Navas (2020); implies

that the pandemic is generally nearing an end, especially assuming that the Chilean government will continue to institute mitigation measures.

CONCLUSION & RECOMMENDATIONS

There is no doubt; the COVID-19 pandemic is an important international test for the medical and scientific community, as it reveals weaknesses in the management of emerging viral diseases and reminds us that contagious diseases should never be underestimated (WHO, 2020; Kolifarhood *et al*., 2020). Chile, just like any other country in any part of the world, has not been spared by this pandemic and hence the need for forecasting and control. Based on 252 daily observations of COVID-19 cases in Chile, this study used the ANN model to come up with daily forecasts ranging over the period November 2020 to April 2021. The results of the study hint that the whole out-of-sample period could be the beginning of the end of the pandemic in Chile. Despite the predicted further decrease in COVID-19 cases in Chile, the government of the country should continue to implement strong control and preventive measures in order to save as many lives as possible.

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